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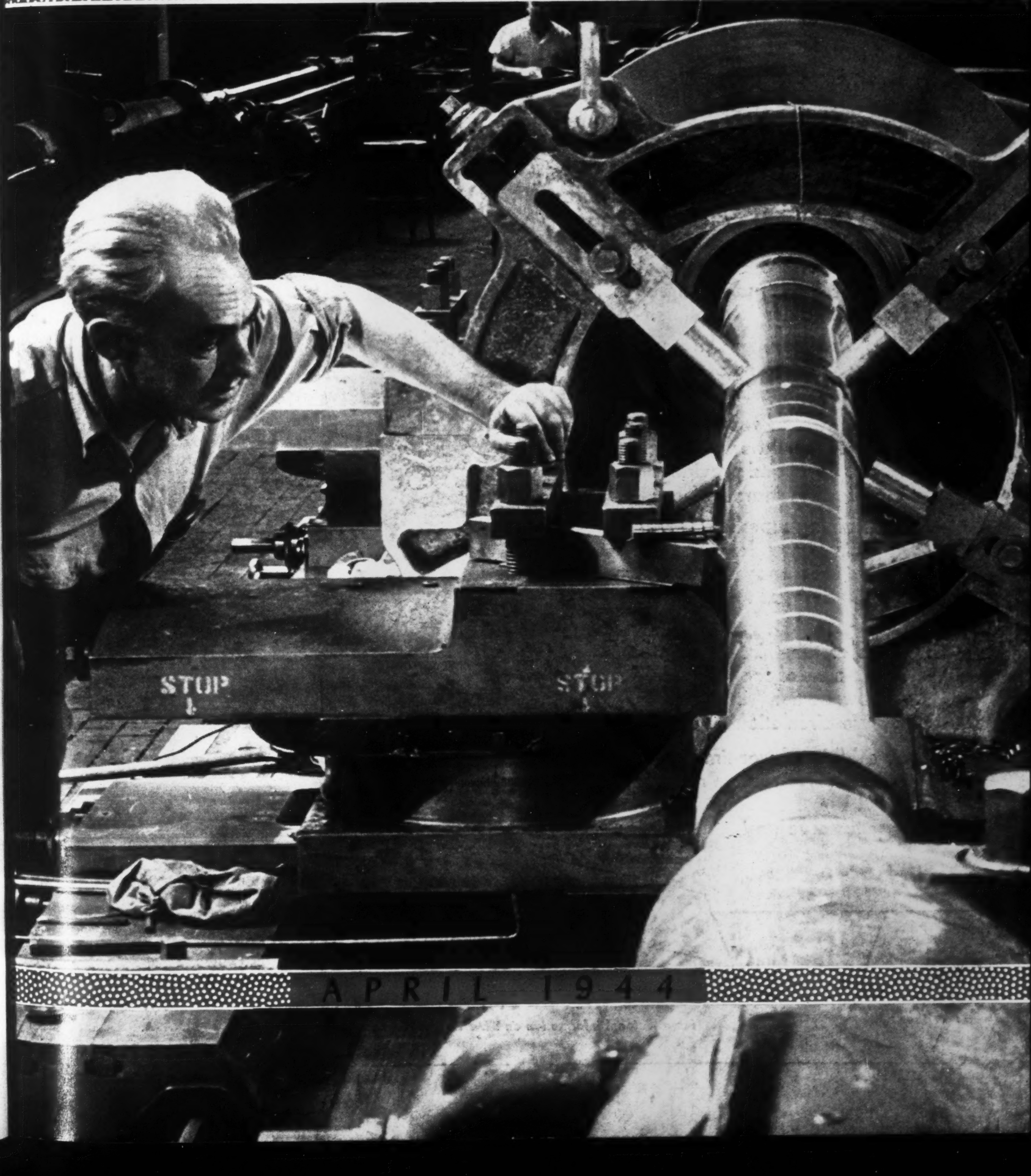
MECHANICAL ENGINEERING



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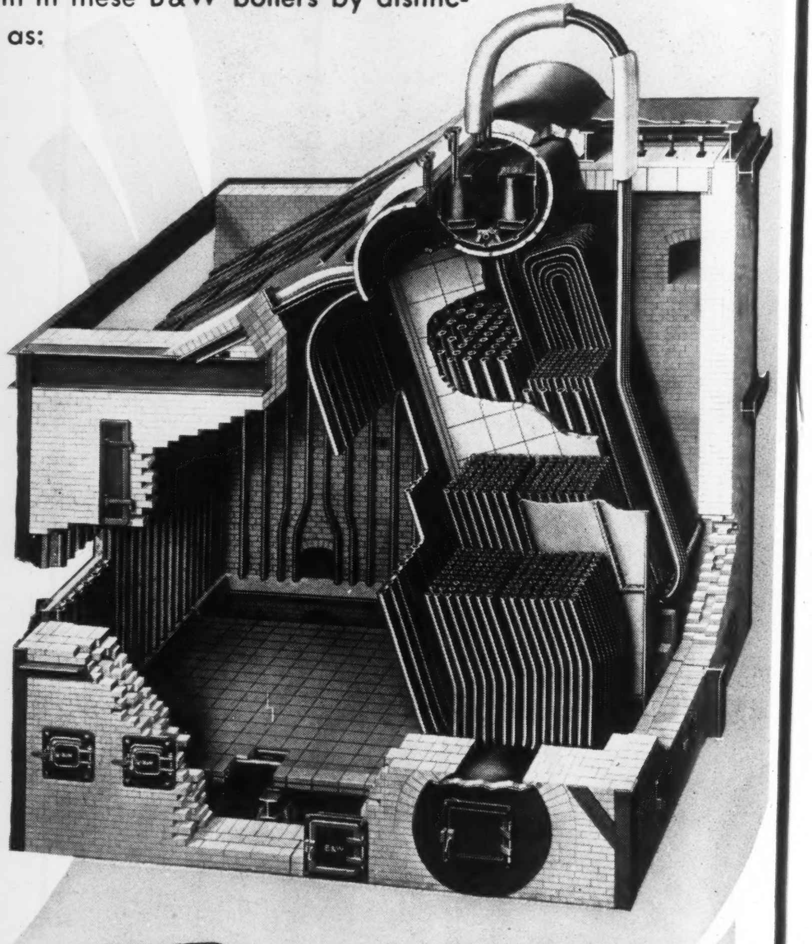

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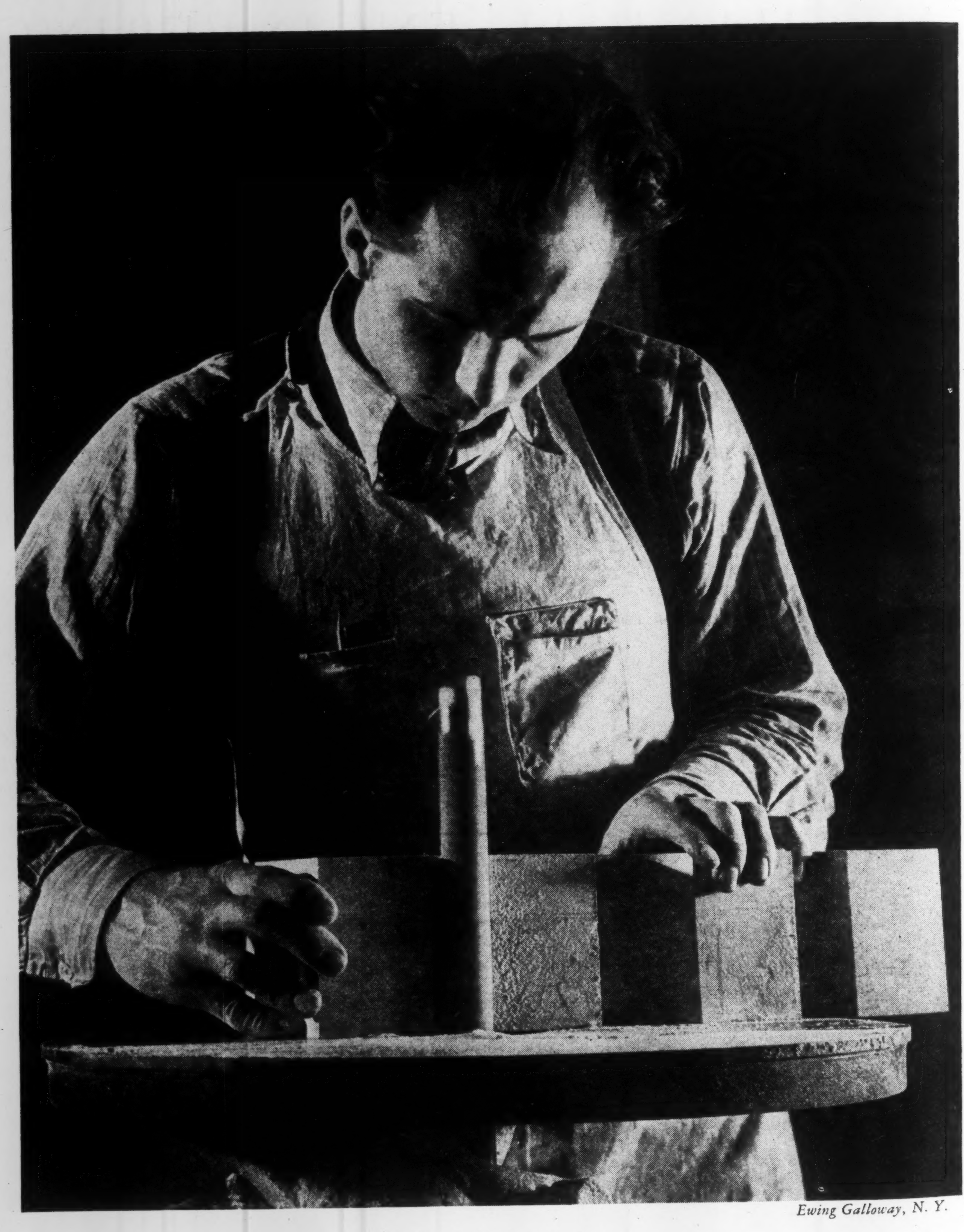

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MECHANICAL ENGINEERING

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1944

GEORGE A. STETSON, *Editor*

Design for Safety

ALTHOUGH few machines would have purpose or value if it were not for the men who must operate them, a major portion of the ingenuity and skill of designers has inevitably been directed to the machine, sometimes at the expense of the man. The designer's first task is to get his machine to work. What effect it may have on the man who operates it or, more remotely, on the lives and institutions of men are factors that come in for later consideration.

The axe, for example, is a very ancient tool and in many ways a very simple one. As J. W. Roe, and probably others, have pointed out, the axe handle has gradually developed into an element of design admirably suited to its purpose and to the man who uses the axe. Generations of experience have produced a tool almost perfectly co-ordinated with the man. How much scientific knowledge of materials, mechanics, and the human body were consciously put into this remarkable evolution, it would be hard to say. Perhaps it could be further improved. Whatever the facts of the case may be, the axe remains as an interesting example of the adaptation of the machine (in this case a tool) and the man.

Almost any tool, machine, or structure will provide other interesting examples of how well or how poorly machines and men have been considered by designers. Engineers, particularly during the last generation or two, have given an increasing amount of attention to this important factor in machine design. There has been a growing tendency to think of the operator—his convenience, comfort, safety, fatigue, efficiency—as well as the machine. Noteworthy progress has been made; but ahead of engineers are goals to be sought in this field as their knowledge of man himself grows. Interchange of knowledge and experience between the profession of medicine, in its broad sense, and that of engineering will spur progress toward these goals.

Much progress has been made, particularly in the field of industrial safety, in this interchange of knowledge. Protection of workmen from industrial hazards—toxic atmospheres, for example—would be relatively ineffective without some knowledge of the human body. Until knowledge of the effects of toxic atmospheres is shared by those responsible for the men exposed to them, little can be done to overcome them. Fortunately, such knowledge is becoming widespread and where indifference to occupational hazards fails to devise protection, the law compels attention to safeguards.

There are other examples of hazards, however, in which progress toward safety has not been so great and in which the law has, as yet, taken only the first and most elementary steps. The newness of the machine itself is responsible in a large measure for some of this apparent backwardness; but in addition to this factor there must be added the lack of understanding that the designer frequently has of the human body and of its weak and strong points.

Just as The American Society of Mechanical Engineers interested itself in the subject of safety in elevators and studied not only the machine itself but also the characteristics of the human cargo it carried, so other areas of safety where men and machines are concerned can be investigated, once designers direct a greater amount of attention to the man. In the field of airplane safety, the Committee on Biomechanics of the A.S.M.E. Aviation division, of which Prof. Frederick Teichman, of New York University, is chairman, is concerning itself with this problem, with the assistance of the medical and engineering professions.

At the 1943 Annual Meeting of the A.S.M.E. the Biomechanics Committee conducted its first public session. One of the papers presented at that session is published in this issue. In this paper the author, who has made extensive studies of survivals from falls from great heights and from airplane crashes, explains some of the factors involved in protecting the lives of pilots and occupants of airplanes.

Professor De Haven's paper discloses the truly remarkable ability of the human body to withstand the effects of accidents, such as airplane crashes, provided the safety environment of the pilot has been properly considered by the designer. It presents a challenge to engineers to pay more intelligent attention to this safety environment. If a human body can survive a fall of 145 ft, cannot engineers devise an airplane structure that will provide the pilot with a maximum of protection in the event of a crash? Undoubtedly, engineers can go a long way toward providing this protection once they put their minds to it and consider the design of the structure in connection with the human body.

The problem is not a simple one. Greater safety-mindedness and confidence that improvements can be made are steps toward the goal. To aid in this worthwhile effort is the task which the Biomechanics Committee has set for itself.

Professional Mindedness

PERHAPS never before has it been quite so important for the engineer to think about his profession as it is today. In a world of rapid change and shifting emphasis on values, the engineer finds himself torn loose from his moorings of individualism and professional mindedness and swept along with a current of labor unrest and upheaval that threatens to overwhelm him. Militant self-interest, collective security, and desire for power on the part of minorities create conditions which the engineer cannot ignore because he is drawn into them, willy-nilly. Confused, in many cases frustrated in his desire to remain an independent and professional individual, this forgotten man of industry does well to ask himself, does an engineer need his profession?

In a brief article in this issue W. E. Wickenden gives some affirmative answers to this question. The article is the concluding section of a new edition of President Wickenden's famous address, "The Second Mile," delivered before The Engineering Institute of Canada in 1941 and widely reprinted in this country. Through the Engineer's Council for Professional Development about 21,000 copies of the original address were distributed. By special request President Wickenden has rewritten the address, with particular attention to the needs of the young engineer, and the new text has been issued by E.C.P.D. in pamphlet form under the title, "The Second Mile—A Resurvey, 1944." A new section, entitled "Does an Engineer Need His Profession?" which is reprinted in this issue, has been added.

It is not an easy task for the engineer to resurvey his own convictions in respect to his profession under present conditions but it is all the more important that he do so.

With tradition and possibly prejudice strongly compelling some men to think too lightly of current trends, and with self-interest, personal grievances, or a spirit of adventure in new fields of social organization influencing others, engineers are likely to hold conflicting opinions on what a profession is and their need for a profession.

President Wickenden's views appeal to those instincts in engineers which have led them to consider themselves professional men, even if they could not always describe in simple language what a profession was or what it meant to them.

Each man must decide for himself how far along the "second mile" he is willing to travel and how heavily the need for his profession lies upon him. The finer qualities of a profession that have been so conspicuously displayed by generations of engineers are bred in the very fiber of their being. They will continue to exist in spite of social change.

War Manufacturing Committee

IN these pages in May, 1943, appeared an announcement of the formation of the A.S.M.E. Manufacturing Engineering Committee at the request of, and under contract with, the Office of Production Research and Development.

The Manufacturing Engineering Committee handles specific problems referred to it by O.P.R.D. in such fields as production research, processes, manufacturing techniques, and materials. It has chosen to operate without fanfare of publicity, but a recent report to the Executive Committee of the A.S.M.E. Council reveals the fact that 34 projects have been handled by the committee since its organization.

Under the chairmanship of L. C. Morrow the Committee, which is composed of Mr. Morrow, Harold V. Coes, Fred H. Colvin, Eric Oberg, and Col. James L. Walsh, has met every week with their executive secretary, Herbert B. Lewis. Representatives of O.P.R.D. are frequently present at these meetings. The projects before the committee are discussed, progress reports of the executive secretary are received, and decisions regarding appropriate action are taken.

By far the most comprehensive project undertaken by the committee concerns high-speed milling with cutters of new design of the carbide type. In its first public appearance on an A.S.M.E. Annual Meeting program in 1943 the Committee sponsored a symposium on this subject. This is a very active subject and one which is exciting considerable interest on the part of industry at large. Already papers on the subject have appeared in MECHANICAL ENGINEERING and more are to follow in later months.

The report of the War Production Committee states that under the pressure of production demands the aircraft companies, mainly on the Pacific Coast, which Mr. Lewis has visited several times, discovered that cutters with carbide cutting blades could be used economically at surface speeds of 5000 to 24,000 ft per min and feeds ranging from 60 to 400 in. per min when machining aluminum alloys like 14-ST. In the case of steel milling-cutter surface speeds ranging from 250 to 1000 ft per min with feeds from 7 to 30 in. per min are in use, depending on the type of steel, its condition, and the type of cut, using carbide cutters with negative rake and helix angles.

A research project on high-speed milling is already under way at the California Institute of Technology and another project, to be carried out at a Midwestern university is under consideration.

In order to disseminate as widely as possible among all war-production plants in which milling is done the very latest and most practical information available, the A.S.M.E. War Production Committee has been assembling a considerable quantity of data and photographs. The data are edited and the most enlightening photographs of actual jobs are selected and published in loose-leaf form for wide distribution.

More than 11,000 sets of the first groups of data sheets were distributed. With each set was mailed a post card by means of which the receiver could request new sets of sheets as soon as they became available. About 3500 cards were returned as a result of the first mailing and these bore requests for about 7000 sets. This list is growing day by day as more plants see the data sheets and make use of the information they contain. Three sets of data sheets have been printed to date and material for a fourth set is being prepared.

The needs of war production have stimulated developments in metal cutting, as the foregoing evidence indicates, that might have been years in winning acceptance in peacetime. Production engineers have been forced into getting the maximum output from every machine tool in their shops. Instead of adding new buildings and new machines, engineers have pushed to the limit what they have had available. The results have astounded everyone and point to still further developments yet to come when the possibilities already uncovered are explored in detail in laboratory and shop.

HOW CAN WE DEVELOP INVENTORS?

By CHAS. F. KETTERING

VICE-PRESIDENT AND DIRECTOR OF RESEARCH, GENERAL MOTORS CORP., DETROIT, MICH. MEMBER A.S.M.E.

I THINK this question of how can we develop inventors, or inventions, because that is the real problem, is one that should concern us greatly. There are many different ideas of what an invention is. The inventor has one idea, the manufacturer has a different one, and the patent attorney has still another. Sometimes it takes quite a high order of intelligence to detect any similarity between them. I mean this seriously—it is a common thing for an inventor not to understand the patent on his own invention.

Likewise, there is no sharp line of demarcation between invention and research except for this distinction—that invention has to do with a specific result, while research is concerned with the determination of those factors which may be necessary in the development of that result.

Some years ago a survey was made in which it was shown that if a person had an engineering or scientific education, the probability of his making an invention was only about half as great as if he did not have that specialized training.

Now that is very interesting, and I have spent a great deal of time wondering why it is so. As a result, I have arrived at a definition of what an inventor is. An inventor is simply a fellow who doesn't take his education too seriously.

You see, from the time a boy is six years old until he graduates from college he has to take three or four examinations a year. If he flunks once, he is out. But an inventor is almost always failing. He tries and fails maybe a thousand times. If he succeeds once, he is in. These two things are diametrically opposite.

We often say that the biggest job we have is to teach a newly hired boy how to fail intelligently. We have to train him to experiment over and over and to keep on trying and failing until he finally learns what will work.

We also have to teach him that everything is not in the books. In his education he invariably gets the idea that this is so because his textbook is always the last word and final authority on whatever he is studying. If we fail to do this, sooner or later he will say, "There is no sense trying this experiment because page 284 of this book says it won't work."

Then we have to explain that these things we are doing have never been done before. If they had, we wouldn't go to all the trouble of repeating them. The books used to say we couldn't build a Diesel injector to operate at 20,000 pounds per square inch. What it really meant is that an injector couldn't operate at that pressure if it was built as the book specified. Today we have hundreds of thousands of injectors operating at pressures much higher than that. The point is simply that no matter what we are doing, if it is new we can always find a book that will tell us it can't be done. Any time we want to stop a project, all we need to do is assemble a committee and tell them about it. Immediately they will tell us we were crazy to start it. So to protect ourselves we have made this very simple rule: When you start a new problem, stay away from the library because it may handicap your thinking.

In training an inventor, how closely do we want him to work with the library? Should he see what has been done first, or should he start out with his own ideas and then go back to the books after he has got a little way along?

The first step is always to set up the problem. When we have done that, we say, "Here's the way we think we ought to proceed," and then go to the library to see what others before us have thought about it. But if we go to the library first, few of us are strong enough to stay out of the rut that may be set up. So another thing we must do in developing an inventor is to teach him to analyze his problem. If he decides that it is worth working on at all, what is the probable first experiment he should try?

Many people want to go beyond the first experiment in their predictions. "If this experiment works," they say, "we will do such and such next." But we should not worry about that. If we knew what was going to happen, we wouldn't need to experiment in the first place. We should realize that prior to the first experiment our ignorance factor may be as much as 100 per cent.

"But suppose the experiment doesn't work the way we think it should?" they ask us.

The chances are ten to one it won't. That shouldn't deter us, however, from going ahead and trying it. After all, an experiment that fails is simply an experiment in which we are wrong. Rarely does an experiment mislead us, providing we are intelligent enough to follow as it directs.

If an experiment doesn't work the first time, it must be tried again; and when a successful experiment is obtained, a continuity can be laid out for going on to the next step. We can then decide what the second experiment should be and go through with it in exactly the same manner. Since none of us is ever smart enough to arrive directly at the final result, we must work our way very laboriously from experiment to experiment and from test to test until we finally get there.

A lot of people don't want to do this. They would like to find a short cut for the tedious trying and failing of experimentation. They think they are smart enough or educated enough to get the result directly. Unfortunately, the only people who have ever accomplished anything in science or engineering are the ones who never thought they were smart enough to get irked by having to try things to see if they would work.

A man who had seen a test of one of our Diesel engines came to see me the other day. That is a very efficient engine," he said. "I would like to talk to your thermodynamics expert about it."

"I am sorry," I replied, "we don't have anyone here who even understands the word 'thermodynamics,' much less be an expert on it. But if you want to know how we developed this engine, I'll be glad to show you."

I took him to our dynamometer room and showed him our single-cylinder setup and told him how we had tried one thing after another for about six years until the engine itself finally told us exactly what it wanted.

"Goodness," he said, "that's an awfully tedious way to design an engine."

"It is," I agreed, "but it is the only way we know."

We don't know how to do any new job without going through all that tedious cut-and-try. Therefore, the next thing

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Contributed by the Committee on Education and Training for the Industries and presented at the Annual Meeting, New York, N. Y., Nov. 29–Dec. 3, 1943, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

we must tell these young engineers is that tediousness is something they must endure and not resent even though they have a technical education.

These things seem extremely simple, but they are basic to the problem of developing inventors.

The point is that we don't solve a technical problem or make an invention in the laboratory. We do these things in our heads. All this laboratory apparatus is simply to help us get an understanding of the problem we are working on. I think the thickness and density of the human skull can be very well represented by the amount of apparatus we sometimes need simply to force an idea through a quarter inch of skull bone. That is why it is so important that we develop proper attitudes in the people we are training to be inventors.

About ten years ago we started a new study of the strength of materials which was based entirely on testing a production piece under simulated working conditions. In other words, if we were interested in a crankshaft, we would build a testing machine that would load that crankshaft exactly as it is loaded in the engine, that is, a load fluctuating so fast with so much tension, so much torsion, at such a temperature, etc. We did that because we had learned that tests on standard test specimens gave us information of a very unsatisfactory kind and that when we tried to test a piece to failure in an actual engine the resulting debris was such that we couldn't tell just what had happened.

In our machine we put anticipators on a piece so that the instant a failure started the load would be released automatically and we could see exactly where the trouble had started.

With this machine we have been able to improve the fatigue life of many mechanisms as much as 500 per cent simply by seeing *how* and *why* the failure starts and by then making very small changes in fillets or slight shifts in temperature during heat-treatment.

We couldn't have calculated these things. No one is smart enough to make such calculations. It has to be a very primitive sort of study which goes back to the very elementary process of trying a thing, learning its weaknesses, and then trying something else.

One of the problems which a research laboratory will always have is how to get along with the manufacturing end of the particular organization to which it belongs. The production man has a problem, and he brings it to us to solve. We analyze it and write a report on our solution. If we use a lot of logarithmic curves and fancy nomenclature the production man never heard of before, he gets mad because he can't see that we have helped him very much. I don't blame him.

To avoid that difficulty, we have worked out a very simple procedure. Before a special report is distributed, it is carefully read by someone in our organization who knows the person for whom the report is intended, and a little circle, or goose egg, is drawn around every word that he thinks may be misunderstood. Then we call in the research engineer and ask him to read the report aloud—but skipping the words that are circled. He starts reading and then exclaims, "My goodness, if you are going to leave out all those words, it won't make any sense at all!"

"All right," we say, "perhaps the reader won't understand those words, so it is just the same to him as if they weren't there at all. If we are going to help with this problem, we must use words that will be understood."

One of these reports had to do with noise and the word "decibel" appeared several times on every page. The boys couldn't find a simpler word for decibel, so with every copy of that report we supplied a little noise box that had ten keys on it. If the report said the noise level was seven decibels, the reader just punched the key marked "seven" and he could hear exactly what seven decibels of noise was.

This question of words and the meaning that we attach to words has always been very interesting to me. It is like the formula problem in which, if a fellow knows the formula for something, he thinks he understands all about it. A lot of people think that if they know the name of something, that's the whole story.

As an illustration, I once asked a famous scientist this question: "Why can I see through a pane of glass?"

"That's very simple," he said. "Glass is transparent."

"I'm afraid the word 'transparent' means nothing at all to me," I replied.

"The word 'transparent' simply means anything you can see through," he said. "Why do you want to know that?"

"I would like to know *why* I can see through a pane of glass. I would like to know whether light waves travel through the glass as light—or whether they are received and rebroadcast in some other form from molecule to molecule. If I knew that, I would be better able to decide some other things I would like to know."

"The trouble with you," he said, "is that you are a modelist; you want an image of something. Modern science doesn't form images any more. We stopped that a hundred years ago. Give me a better problem—something a little more practical."

"All right, here's one: When I rub my hands together, why do they get warm? Why shouldn't they get cold?"

"Oh, that is quite simple—it is due to friction."

"Yes," I said, "now what is friction?"

So we argued back and forth for three quarters of an hour and finally we came to the profound conclusion that we don't know anything about friction—except that friction is a thing that makes your hands warm when you rub them together—and we don't even know how it does that.

A few years ago I assigned a young man to work on this friction problem and had him rub little pieces of metal to see how much they wore away, how much heat they generated, and so on. After he had been working on it for a little while, I stopped in to see him. "How are you coming along?" I asked.

"Not very well," he replied, "Don't you think this is an awfully childish problem for a fellow who has the kind of education I have?"

I didn't think so, or I wouldn't have assigned him to it, so I asked what the trouble was.

"It wouldn't be so bad," he exclaimed, "if it wasn't all in the books!"

"I'm glad you mentioned that," I said, "because if we have you working on this thing when it's all in the books, like you say, then we ought to stop right away. But before we do that, I want you to show me that book. If you can find that book or any book like it, I will give you a medal."

I saw him about a month later and asked how he was progressing on the medal business.

"Awful," he said, "I haven't been able to find anything. And I can't understand that, because it's something so fundamental I should think a lot would be known about it. I can't understand it at all. There's not a thing in the books about it."

I want to tell you something of the outcome of this episode because it shows how much we can accomplish if we don't place ourselves too high above our jobs. This same young fellow soon discovered some very interesting fundamental facts about friction and wearing surfaces which have enabled us to produce better piston rings for Diesel locomotives than we ever had before. When we first started to run our locomotives, we had to change rings every 50,000 miles. No one objected to that. They thought 50,000 miles was about as long as a piston ring ought to last. Now we have rings that will last 500,000 miles, and I think we ought to be able to get them to last 1,000,000 miles before we're done.

It was in connection with these same engines that someone once asked how it happened that we were making most of the Diesel-electric locomotives in the country. "You must have awfully good patent protection," he said.

"Well, here's the reason," I said. "You see, a great many people think we're crazy. That is much better protection than any patent."

I would rather have my competitor think I am crazy than have a stack of patents a mile high, because he can easily get around my patents, but if he thinks I am crazy, he won't even bother to check up on them. I was in the automobile starting, lighting, and ignition business for five years without any patent protection at all to speak of, because everyone knew that the breaker mechanism in my ignition system was crazy, and that it wasn't worth copying. They infringed every patent I had, but they didn't infringe my ignorance factor.

I often tell the boys this story: I have been making inventions and taking out patents for many years. When I first began to apply for patents, most of my inventions had been patented 50 or 60 years before. Later I was only 40 years behind—then 30 years—and so on. So I drew a set of coordinates and plotted just how far behind I was on each invention. There was a gentle slope to the curve, so I could extend it to the base line to see how old I would be when I made an original invention. It comes to about 125 years.

If we can succeed in eliminating from a young man's mind the idea that just because he thought of a thing it must be very good, then we can go ahead without the danger of temperament getting into engineering.

We have a little rule in our laboratory which we think solves this problem. It's a very simple rule and the only rule we have. It is just this: "The Job Is the Boss." What does the engineer think of this new piston? That doesn't matter. What does the engine think about it? That matters. The engineer's opinion is worth very little. The engine's opinion is worth a great deal.

If the engine says, "I like this piston," and it happens to be contrary to the engineer's pet idea, that's too bad. It simply proves that the engineer was wrong. After all, as we said, the only reason for all this expensive research is that it corrects our ignorance factor so that we can see the problem in its true light.

Opinions are not the only things that lead us astray. Sometimes we are led into difficulties by certain aspects of the so-called practical side of our educations. We accumulate rules of thumb, arbitrary constants, and formulas. We accept these as fundamental. We should question them whenever we encounter them. They are the stumbling blocks of progress.

There is a formula by which we can calculate the fatigue life of a piece of spring steel which is being stressed under certain conditions. This formula tells us how many thousand cycles of stress the spring will undergo if its surface is perfectly mirror-smooth, how many less if it is slightly rough, and how many still less as its roughness increases. We take a flat piece of smooth spring steel about 3 inches wide and 2 feet long and put it in a test machine and bend it back and forth until it breaks. We find that the standard spring, as furnished by eight or ten different steelmakers, will break in about the same time—at a couple thousand cycles. That checks very closely with the formula. We ask each of the steelmakers to run the same test and their results check with ours. The formula and the experiment agree. Everyone agrees that it is a wonderful proof of the formula and shows there is no use trying to run a spring any longer than the formula says.

Then we say, "Suppose we bang up this piece of spring steel until it is rough all over—then how long will it last?"

After thinking about this for a while, they say, "We don't know how many cycles of stress it will stand, but we all agree that its fatigue durability will be seriously impaired."

So we asked them to make us some more samples. "Put a little mark on them so you can identify them as your pieces," we say. Then we give these samples a little treatment which we call shotblasting, or surface peening, in which we shoot a lot of little hard steel balls at each sample until it is thoroughly roughened. That done, we send the samples back to the steelmakers to be tested.

Then a surprising thing happens. Instead of breaking at 2000 cycles, the samples are flexed up to 2,000,000 cycles and still they don't break. The formula still says they will break at 2000, but they don't know that. They keep right on flexing at 2,000,000. That is quite a gain in per cent.

We have learned that in most problems there is a normal time rate of development which corresponds very closely to the normal yearly increment of improvement made by industry. There is not a great deal that we can do to speed up such improvements, because they are so intimately geared into the whole system that they can be assimilated only at a certain rate. But in other problems, such as certain medical problems, the question of how long it is going to take to solve them is of relatively little importance. The results will justify any expenditure of time. All that is necessary is that the man who is going to work on the problem be shown that it is worth solving, or he won't want to try it.

We had some experience with this in the early days of the ethyl-gasoline development. We had been working on the so-called aromatics for a number of years and had some pretty good results, but nothing really exciting. So some of the boys came up to my office and said, "We are young yet, and we would like to do something in the world, and we don't want to be kept on this problem forever, because we don't see any hope of ever working it out."

I was leaving for New York that afternoon, so I said, "Let me have a couple of days to think this over, and when I come back I'll see if I can't work out something for you."

I thought that it would be wrong to stop this work, even though they had been correct when they said our progress to date was very discouraging. When I got on the train to go back to Dayton, I noticed a newspaper lying on the seat beside me and I picked it up. On the first page there was a little item entitled, "University Professor Discovers Universal Solvent."

That interested me because I happened to know an amusing story about two chemists who were trying to discover a universal solvent. It seemed they talked a banker into loaning them some money and set up a little laboratory just outside of town. One winter morning a farmer had a blowout outside their place, so he came in and asked if he could use their telephone to call up the garage. They said, "Sure, go right ahead." When he was through telephoning, he asked if he could wait there until the garage brought him a spare tire and they said, "Sure, you can." So he stood there watching them for a while, and finally he asked what they were doing.

"We are working on the most important thing in the world," they said. "We are developing a universal solvent."

"What does that mean?" asked the farmer.

"Well, that is a liquid that will dissolve anything you put into it."

"My goodness," said the farmer, "that is marvelous, but what in tarnation are you going to keep *it* in?"

Because I happened to know that story, I was interested in this so-called universal solvent and I read the newspaper story in its entirety. The material referred to was selenium oxychloride.

The next morning when I got to the laboratory I showed this newspaper item to the boys and said, "Here's one we'd better try before we quit," so they went ahead and got some. It turned out to be almost a universal solvent in its action on valves and rings, but it did something that none of us had anticipated. Theoretically, selenium oxychloride should have made the knock worse because it contained both chloride and oxygen, which had been knock-inducers in every other compound we had tested. But instead of inducing knock, selenium oxychloride turned out to be a powerful knock-suppressor. That was our first step into the study of the metallo-organic compounds, which led us through a great many experiments until we finally arrived at tetraethyl lead.

The point of this story is that we must always know whether a problem is worth solving. There will always be dark days, but if your conviction of the value of the problem is such that you go right ahead in spite of the difficulties, the chances are that you will achieve success in the end.

I like to think that we can take even a highly educated young man and teach him to be an inventor without ruining his education. I have only one complaint against our educators and it is that they haven't always told us the complete story.

A friend of mine who teaches general medicine at one of our large universities once told me this story about education. He is an old hand at teaching medicine. He lectures to the classes, teaching the boys to be general practitioners. His system is sound and doesn't differ radically from similar courses in other universities, except for the last lecture he gives the group. That lecture is unique. On this occasion, he says, in part:

"Young men, we are together for the last time. We have had a very pleasant time. You have been a good class and I have enjoyed working with you.

"I have given you the best information available—the best case histories I could find. The textbooks we have used are the most widely accepted and reliable. But before we part company, I want to caution you that the science of medicine is developing so rapidly that in a few years from now perhaps half of the things I have taught you won't be so Unfortunately, I don't know what half that will be."

I have been very interested in co-operative education because I feel that by bringing a boy in contact with both the school and industry we can lap-weld him to a job instead of butt-weld him. I worked with Dean Schneider at Cincinnati for a number of years. I have also been interested in a co-operative system at Antioch; and right before Dean Schneider died, I helped to get him to go out to Northwestern University to set up the co-operative system there.

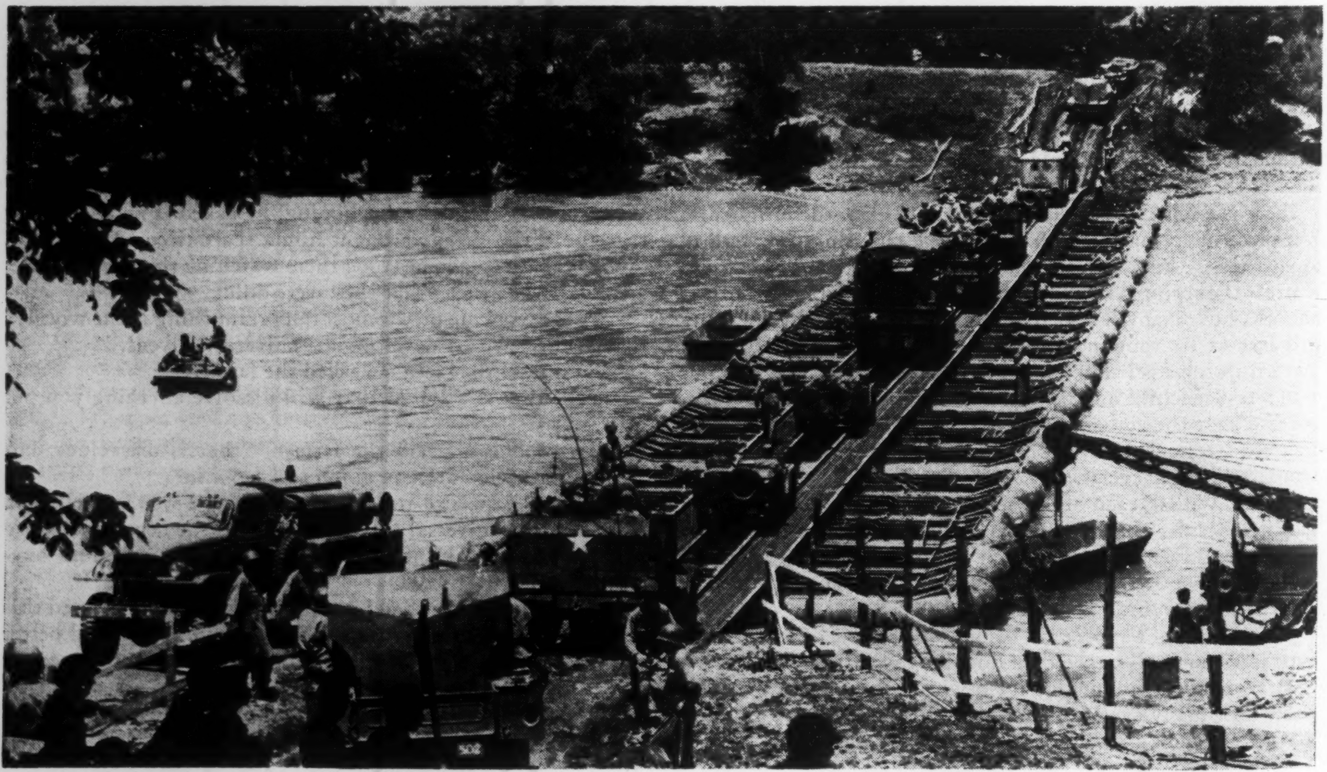
My interest in co-operative education is not limited to having the boys go to school half time and work in industry half time. I don't care how it is done, but I would like to see the university and industry work closer together because I think they should understand each other's problems. I think if we could do that, it would be much less necessary to teach trade subjects in school. We could spend more time on the fundamental broad principles of physics, chemistry, and mechanics.

There are several other ways that this result can be achieved. One is by alternating the professors instead of the students. The instructor could teach half time and, as I once said, work half time. Somebody objected to my saying that, so I apologized, but you know what I mean.

I don't care how we achieve this co-operation, whether it is half-timing the boys or half-timing the instructors, or doing research, just so the educational institutions can teach these boys the fundamentals they will need in their work, and industry can teach them the practical applications it will need from them in its work.

If we can just achieve the broad outlook and be honest with ourselves and admit that the things we know are so small compared with the unknown, I think we will see that there is no end to progress. I am not worried about the libraries we have today—I am worried about those infinitely greater libraries that haven't any books in them yet. Every year is going to add new things and new books that we don't know. I am interested in getting some of those books written.

We should date-line every bit of information we have. We should say, "This is what we know as of today." We shouldn't worry about what it was yesterday—or what it is going to be tomorrow. We should recognize that ideas change and grow, and we should gear ourselves to the most progressive thinking. If we can do that successfully, we will have no difficulty in teaching men to become inventors, because inventing is simply a state of open-mindedness.



Courtesy The Heil Co.

AND THE BRIDGE IS READY FOR BUSINESS!

(Heavy tanks, half-tracks, jeeps rumble safely across—a few hours after the big bridge carriers arrived on the scene. Upstream, assault boats look for floating mines. Overhead, fighter planes protect the span and convoy.)

ADVANCES *in* PLASTICS *During* 1943

By G. M. KLINE

NATIONAL BUREAU OF STANDARDS, WASHINGTON, D. C.

THE chronology of plastics progress in the United States during 1943 is wholly associated with the demands of total war. Plastics have assumed jobs in this national emergency which stand in amazing contrast to their former peacetime roles. The versatility and potentialities of these synthetic materials have become even more evident in these wartime applications. The new materials and techniques which have been developed to meet the exigencies of the hour possess far-reaching possibilities for influencing postwar utilization of plastics.

MATERIALS

The safeguards of censorship have prevented extensive descriptions of many of the wartime arrivals in the materials field. Because these pioneering efforts constitute an interesting and significant phase of developments during this period of vigorous plastics activity, a brief survey of such information as has been made public is presented.

Synthetic replacements for natural mica, one of the most critical war materials because it is a vital component of radio and electrical apparatus, are being developed by several companies. One of these has produced a series of commercial products called Polectron (1).[1] Polectron is said to have an unusual combination of low dielectric loss, high temperature stability, and superior water resistance, but the mechanical strength of the resin as now made is still relatively poor. Immediate uses for the material, such as dielectric sheets in condensers, do not call for a high degree of mechanical strength.

An inorganic mineral element, silicon, has been combined with organic radicals composed of carbon and hydrogen to produce a new group of plastics called Silicones (2). Silicones are said to be resistant to temperatures as high as 500 F, which suggests their suitability for use in certain classes of electrical insulation.

Another new material, a name little known as yet on the plastics roster, is Penacolite. This is said to be a phenolic-type thermosetting resin which cures rapidly at temperatures from 60 to 150 F under nearly neutral conditions. This type of resin may eliminate many of the difficulties in the assembly-gluing of wood or plastic-plywood parts for use where they are continuously exposed to the weather.

Polystyrene has fulfilled many difficult assignments in wartime electronic and aircraft equipment (3). Styraloy (4), a recently developed elastomeric styrene derivative, is reported to have properties which make it eminently suitable for electrical applications at both high and low temperatures.

An adhesive has long been sought that will permit the bonding together of metal, wood, plastics, ceramics, fibers, and rubber in any combination. New entries in the plastics field that appear to possess the desired properties are Cycleweld and Reanite cements, thermosetting plastics which are applied to the surfaces of the units to be bonded and then cured under heat and pressure. This process (5) is said to form stronger, lighter, and cheaper structures than those joined by conventional methods.

Reinforced plastics which permit large volume production of low-cost lightweight high-strength structures offer many advantages beyond the replacement of critical aluminum and magnesium. Several new resins (6, 7), which form satisfactory bonds at low or contact pressures and will thus eliminate the need for costly dies, have been created, and special papers, cotton (8) and rayon fabrics, and glass-fiber cloths (9) have been developed as reinforcing materials. These low-pressure laminated plastics attract interest because they make possible the fabrication of structures heretofore considered impractical and even impossible for plastics.

Resin-impregnated wood such as Pregwood has become an important factor in maintaining an adequate supply of propellers for our expanding air forces. A plant with facilities for producing fifty times the volume of Pregwood manufactured prior to the war is now in operation. Resin-impregnated and compressed maple boards are bonded into blocks by electrostatic high-frequency heating of thermosetting phenolic glues. From these blocks the propellers are carved. Other applications of this wood-plastic material include electrical insulation, bearing plates, skis, and ventilating fans (10–14).

A new rubber-like product, Paracon, made by the condensation of dibasic acids with glycols or by the condensation of hydroxy acids, was announced (15). The elongation at break of these polyesters, which have an average tensile strength of about 1700 psi, is said to average 400 per cent. Important progress was also made in the production and application of polyethylene and its derivatives, but the publications on this subject were limited to the patent literature (16, 17).

Significant reports were published concerning materials which are relatively new to the industry and which have been allocated practically completely to war uses. These pertained to the processing and properties of nylon (18–20), vinylidene chloride (21–23), and vinyl chloride-acetate plastics (24–27). The development of an improved heat-resistant methacrylate molding compound was announced (28). A low-density cellophane product which has some unusual properties and applications was described (29). Other noteworthy papers dealt with phenolic pulp preforms (30), plastics from redwoods (31, 32), soybean-modified phenolic molding compounds (33), and starch plastics (34).

MOLDING AND FABRICATING

Notable advances in molding and fabricating techniques were made during 1943. These have served to extend still further the horizons of the plastics industry. Low-pressure laminating, postforming of laminates, and heatronic molding have passed rapidly through their experimental stages to become new and vital tools in the production of plastic parts for our armed forces.

After several years of intensive research, it is now possible to mold laminated structures at low pressures and at reduced temperatures with a consequent reduction in molding costs. The new technique also removes the size limitations which

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[1] Numbers in parentheses refer to the Bibliography at the end of the paper.

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presses and steel molds had placed upon molded-plastics applications and makes possible the economical production of small numbers of parts. What appeared to many potential users of plastics to be an insurmountable obstacle has thus been overcome. The molds for low-pressure molding can be fashioned from wood, cement, plaster of Paris, or cast metal. A rubber bag inserted in the cavity, or a rubber blanket laid over the mold and clamped tightly at the edges provides the means for applying uniform pressure to the closed dies by means of air, water, or steam. The low-pressure laminates compare favorably mechanically with high-pressure laminates and possess the additional advantage of permitting the formation of complex shapes without rupture of the fibrous reinforcing materials (35, 36).

Postforming of thermosetting materials had its origin in the aircraft industry. Many intricate machines have been devised to make metal sheets take the complex shapes required by that industry. With this background of experience in handling sheet metals, it is not surprising that this same industry was the first to succeed in applying sheet-forming methods to plastic laminates to produce a wide variety of aircraft parts. Again, the important factors in its present and future uses are the ability to produce a few parts with negligible mold costs, the low pressures involved which make unnecessary costly investments in presses and auxiliary equipment, and the simplicity of the operation which is not dependent upon the use of skilled labor. The material is heated until it becomes thermoplastic, and it is then quickly formed over molds made of wood or other suitable materials (37–39). The surprising feature is, of course, the residual thermoplasticity retained by these thermosetting laminates which by definition were "infusible."

Electrostatic high-frequency heating was first applied in the plastics field to the curing of resins used in bonding plywood and in the manufacture of high-density resin-impregnated wood (40). During 1943, this electrical method of heating was adapted to the molding of thermosetting materials. Called "heatronic molding," the process as applied to compression molding consists in heating the powdered or preformed material to molding temperature in the electrostatic field outside of the molding press, followed by a quick transfer to the mold and rapid closing of the press to obtain flow prior to hardening (41–44). The advantages of heatronic molding are ready molding of impact grades of materials, shorter cycles, lower pressures, less abrasion of the molds, less pin breakage and displacement of inserts, and adaptability to molding of thick cross sections.

Other developments and improvements in molding processes and fabrication techniques were described in the literature during the course of the year. Transfer molding (45, 46) and mold design (47) were reviewed, and a comprehensive survey of molding tolerances (48, 49) was made. Recommendations were published concerning good practices in the machining of laminates (50, 51). A new application of electronics to plastics problems was the sealing of packages made up of thermoplastic film by passing the lapped material through a high-frequency electrostatic field (52).

APPLICATIONS

A recounting of new uses of plastics during 1943 is necessarily another chapter in the story of meeting war-matériel needs with these synthetic products. Plastics are used by our armed forces in every sphere of the war. It is noteworthy, however, that nearly twice as many reports were published on aircraft applications of plastics as on all other war uses. This evidence of interest and activity in plastics on the part of the high-priority aircraft industry augurs well for a continuing market for these materials in the aviation field. This contact has been a fortunate one for the plastics industry in that it has led to the development of methods for utilizing plastics for the manufacture of relatively small numbers of parts of moderately large size, as compared with prewar emphasis on mass production of small shapes. It has also brought a demand for engineering data on the properties of these materials so that they can be used most effectively in structural and semistructural parts. The accumulation of these technical data during the war period will pave the way for broader industrial postwar applications of plastics.

Several reviews concerning the utilization of plastics for aircraft purposes were published (53–58). Other reports described specific applications, such as propellers (59), windshields (60–63), ammunition boxes (64), gun turrets (65), engine parts (66–68), antenna masts (69), jettison tanks (70), barrage-balloon valves (71), speed indicators (72), bomb racks (73), fairings, doors, wing and tail parts (74, 75) and miscellaneous fittings. Plastics were used in drop-hammer and hydraulic-press punches for forming metal sheets into aircraft components (76–78).

A commendable job has been done by the National Aircraft Standards Committee in standardizing plastic tubing and tube fittings for aircraft use (79). The reduction in the number of sizes and shapes of parts thus brought about makes the use of plastics feasible and economical and simplifies inventory and servicing problems. A comprehensive survey of the activities of technical committees concerned with research, specifications, standardization, and publications was issued, following a meeting in Washington to co-ordinate this work, particularly in its aircraft phases (80).

Many developments in the use of resin-bonded plywood for aircraft construction were reported during the year. This triple alliance of the aircraft, plastics, and wood industries has transformed an old material into a versatile product adaptable to the methods and needs of modern industry. Further progress in improving the properties of plywood and extending its markets is to be expected from the current activity in the synthesis of new resins which will produce satisfactory bonds at very low pressures and room temperature under practically neutral conditions.

The construction of airplanes from plywood was discussed in several papers published during 1943 (81–87). Special problems involved in molding monocoque structures from sandwich materials comprising high-strength facing sheets bonded to low-density cores were reviewed (57, 88). The use of resin-bonded plywood for seaplane floats (89), refrigerator cars (90), and tubular antenna masts (91) was reported.

Advances in synthetic-resin glues (92–95) and in bonding and forming techniques (96–98) were described. Problems involved in formulating and evaluating finishes for plywood were analyzed (99). The behavior of plywood under various stress conditions (100, 101) and in delamination tests (102) was reported.

A variety of items developed or made during 1943 from plastics for the armed forces were described (103–106). Special articles considered in detail such applications as fuses (107), bomb recorder frames (108), gas-mask parts (109), snake-bite kits (110), canteens (111), helmet liners (112), insignia (113, 114), hand grenades (115), foot tubs (116), handwheels (117), training bayonets (118), "walkie-talkie" microphones (119), bugles (120), tank periscopes (121), ship-propeller bearings (122), and binocular carrying cases (123). Excellent surveys of the large-scale utilization of plastic-coated fabrics for fabricating military equipment were published (124). The use of resinous coatings for protecting steel shell cases against corrosion (125) and for other military requirements was reviewed (126).

The nonmilitary applications of plastics during 1943 were restricted to essential civilian and industrial requirements. Many of these represented replacements for materials, such as rubber, leather, and copper, the supplies of which were even more critical than that of plastics. Polyvinylidene chloride was used as piping (127–130), screening, and moistureproof packaging material (22, 23), (131, 132). The vinyl resins were employed extensively as flexible electrical insulation (133) and in soles for shoes (134). The ion-exchange resins were utilized in many industrial processes for purification of water (135, 136).

Reviews were published discussing the uses of plastics in adhesives (137, 138), medical supplies (139), printing plates (140, 141), synthetic textile fibers (142), railway equipment (143–145), and building construction (146, 147). Significant developments in improving the optical properties and extending the optical applications of plastics were described (148–151). Large tonnages of these synthetic materials were used in protective coatings; advances in this field were discussed in several papers (152–155).

PROPERTIES, TESTING, SPECIFICATIONS

A record number of papers describing experimental work on plastics were published during 1943. These marked continuing efforts to supply the military services with the engineering data required for proper use of plastics in their war applications. The technical data made available through these publications provide a foundation upon which the plastics industry can build diverse and substantial markets in new fields after the war.

This Society, through its Rubber and Plastics Group, sponsored many of these technical papers. Reports on investigations of the bearing strength of plastics (156) and their behavior under sustained vibrations (157) were published by the Society. Other A.S.M.E. papers dealt with the mechanical properties of cellulose acetate (158), and the effects of continuous heat on phenolic materials (159). Three papers on plastics were presented at the Semi-Annual Meeting in Los Angeles in June; these pertained to the thermoelastic forming of airplane parts (39), properties of Fiberglas laminates (160), and laminates made by combinations of wood with cloth and paper (161). The Annual Meeting of the Society in New York in December was marked by six further contributions to the fund of information on plastics. These reports concerned paper-base laminates (162), tubing and fittings for aircraft (163), fatigue behavior of resin-bonded plywood (164), creep properties of phenolic plastics (165), printing plates (166), and application of plastic films and solutions to glass to prevent scattering during air raids (167).

Three outstanding papers on the strength characteristics and testing of plastics were presented at the Annual Meeting of the American Society for Testing Materials in June. These related to impact testing (168), flow of plastics under load (169), and correlation between impact and fatigue tests (170).

An important symposium on the engineering properties of plastics as applied to aircraft components was held during February under the sponsorship of the Army-Navy-Civil Technical Subcommittee on Plastics. Three papers giving detailed information on the mechanical strength of laminates were presented (57, 171, 172). Other reports, describing experimental work on plastics conducted by the Army Air Forces and Naval Air Experimental Center, were published during the year (173–175).

Several papers described investigations of the physical properties of the increasingly important group of elastic plastics; these dealt with their fatigue resistance (176), abrasion resistance (177), stress-strain characteristics (178), and low-temperature brittleness (179). Studies of the behavior of urea-formaldehyde molding compounds under various curing and conditioning treatments were reported (180, 181). Chemical (182) and physical (183) properties of laminates were discussed. A review of the strength and optical qualities of cast methyl-methacrylate sheet plastic was published (184). Other topics included mechanical strength at low temperatures (185), ignition points (186), electrical properties (187), and toughness (188).

Three noteworthy guides to identification of plastics appeared in the literature during 1943. Two of these pertained to resins used in commercial molding compounds (189, 190) and the third was concerned with plywood glues (191).

Committee D-20 on Plastics of the American Society for Testing Materials completed action on a record number of testing methods and specifications. Six new tentative methods of test were adopted and six others were advanced to the status of standard methods. Sixteen specifications were prepared by Committee D-20 and approved by the Society. These covered phenolic, urea, melamine, styrene, vinyl-chloride-acetate, vinylidene-chloride, cellulose-acetate, and cellulose-acetate-butyrate molding compounds; cellulose nitrate, cast-methacrylate, vinyl chloride-acetate, and laminated thermosetting sheets, rods, and tubes; and nonrigid vinyl-chloride, vinyl-chloride-acetate, vinyl-butyral, and ethyl-cellulose plastics. The development of many other testing methods and specifications has been undertaken by this committee.

BOOKS ON THE SUBJECT

A review of advances in plastics during 1943 would be incomplete without mention of several excellent contributions in book form to the technical and trade literature. The Plastic Materials Manufacturers' Association issued a compilation of technical data on plastic materials (192). The Society of the Plastics Industry prepared bulletins dealing with assembly gluing (193) and extruded plastics (194). The American Society for Testing Materials brought together in one booklet all of the specifications and testing methods developed by the Society for users and manufacturers of plastics (195). Two further additions were made to the American literature on the chemistry of high polymers (196, 197). The growing alliance between agriculture and industry as typified by the use of raw materials from the farm and forest in the manufacture of plastics was reviewed in a nontechnical vein (198). A comprehensive reference work on the physical and chemical properties of plastics and their production, fabrication, and application was published (199). At the close of the year another edition of the well-known plastics catalog appeared; it has been expanded by new articles and charts covering all phases of the plastics industry (200).

BIBLIOGRAPHY

MATERIALS

1 "Mica Replacement," *Scientific American*, vol. 169, July, 1943, pp. 11, 12.

2 "Silicones," *Modern Plastics*, vol. 20, April, 1943, p. 114.

3 "Polystyrene for Wartime Electronics," by F. E. Wiley, *Modern Plastics*, vol. 20, August, 1943, pp. 80, 81, 134, 136.

4 "Styralloy," *Modern Plastics*, vol. 20, April, 1943; Plastics Catalog 1944, Plastics Catalogue Corp., New York, N. Y., p. 896.

5 "Cycleweld—A New Bonding Process," *Modern Plastics*, vol. 21, September, 1943, pp. 65–69, 152.

6 "New Allyl Alcohol Type Resins," by Irving Muskat, *Modern Plastics*, vol. 20, March, 1943, p. 98C.

7 "Allyl-Type Cast Resins and Laminates," by A. Pechukas, F. Strain, and W. R. Dial, *Modern Plastics*, vol. 20, June, 1943, pp. 101–104, 138.

8 "Plastic-Bonded Cotton Fiber," by M. A. Goldman and G. A. Olsen, *Textile Research*, vol. 13, December, 1942, pp. 25–32; *Modern Plastics*, vol. 20, May, 1943, pp. 100, 130, 132.

9 "Fiberglas Reinforced Plastics," by T. S. Rogers, *Modern Plastics*, vol. 21, September, 1943, pp. 88, 140–142.

10 "Resin Impregnation of Wood," by Ralph Casselman, Mechanical Engineering, vol. 65, October, 1943, pp. 737, 738, 744; *Modern Plastics*, vol. 21, November, 1943, pp. 124–126, 168.

11 "High-Density Plywood," by Malcolm Finlayson, Trans. A.S.M.E., vol. 65, 1943, pp. 193–199.

12 "A New Wood Material—Hydulignum," *British Plastics*, vol. 14, December, 1942, pp. 381–384.

13 "Resin Laminated Densified Wood," by A. E. L. Jervis, *Plastics*, vol. 7, March, 1943, pp. 122–127.

14 "Synthetic-Resin-Laminated Wood Insulation," by A. E. L. Jervis, *British Plastics*, vol. 15, September, 1943, pp. 223–228.

15 "Paracon—A New Polyester Rubber," by B. S. Biggs and C. S. Fuller, *Chemical and Engineering News*, vol. 21, June 25, 1943, pp. 962, 963.

16 "Ethylene Polymers," by B. J. Habgood, U. S. Patent 2,316,418, April 13, 1943.

17 "Polyethene Dispersions," by A. S. Gomm, U. S. Patent 2,313,144, March, 9, 1943.

18 "Winding-Wire Covering," by H. C. Gee and J. F. Cowen, *Electrical Review*, vol. 133, July 30, 1943, pp. 134–136.

19 "Improved Formulations Will Expand Postwar Uses of Nylon," *Product Engineering*, vol. 14, September, 1943, pp. 599–600.

20 "Injection Molding of Nylon," by R. B. Akin and J. E. Teagarden, *Modern Plastics*, vol. 21, November, 1943, pp. 115–120, 166.

21 "Vinylidene Chloride Polymers," by R. C. Reinhardt, *Industrial and Engineering Chemistry*, vol. 35, April, 1943, pp. 422–428.

22 "Saran Film—Its Properties and Wartime Uses," by W. R. Dixon and H. L. Schafer, *Modern Packaging*, vol. 16, July, 1943, pp. 72–73, 107–108.

23 "Saran Film," by F. J. MacRae and H. L. Schafer, *Modern Packaging*, vol. 17, December, 1943, pp. 96–99, 152.

24 "Coloring Materials for Copolymer Vinyl Chloride-Acetate Compounds," by F. G. Clark, *Industrial and Engineering Chemistry*, vol. 35, March, 1943, pp. 368–374.

25 "Vinyl Compound Combats Corrosion," *Modern Plastics*, vol. 20, March, 1943, pp. 85, 86, 146.

26 "New Plasticizers for Vinyl Resins and Cellulose Esters," by D. W. Elam, H. M. Preusser, and R. L. Page, *Modern Plastics*, vol. 20, May, 1943, pp. 95–97, 146, 148, 150.

27 "Behavior of Plasticizers in Vinyl Chloride-Acetate Resins," by M. C. Reed, *Industrial and Engineering Chemistry*, vol. 35, August, 1943, pp. 896–904.

28 "Improved Heat-Resistant Methacrylate," by G. M. Kuettel, *Modern Plastics*, vol. 20, June, 1943, pp. 98–100, 136, 138.

29 "Technical Data on 'Bubblefil,' " by J. B. Quig, *Rayon Textile Monthly*, vol. 24, February, 1943, pp. 77, 78; March, 1943, pp. 119–121.

30 "Phenolic Resin-Pulp Preforms," by R. U. Haslanger and R. H. Mosher, *Modern Plastics*, vol. 20, July, 1943, pp. 76, 77, 130.

31 "Steering With Redwood Wheels," *Modern Plastics*, vol. 20, January, 1943, pp. 77–81, 136.

32 "Plastics From Redwoods," by H. F. Lewis, Mechanical Engineering, vol. 65, 1943, pp. 515–517; *Modern Plastics*, vol. 20, July, 1943, pp. 91, 92, 134.

33 "Soybean—Modified Phenolic Plastics," by L. L. McKinney, R. Deanin, G. Babcock, and A. K. Smith, *Industrial and Engineering Chemistry*, vol. 35, August, 1943, pp. 905–908.

34 "Possible Industrial Utilization of Starch Esters," by J. W. Mullen, II, and E. Pacsu, *Industrial and Engineering Chemistry*, vol. 35, March, 1943, pp. 381–384.

MOLDING AND FABRICATING

35 "Low-Pressure Molding of Laminates," by F. P. Wilson and N. D. Hanson, *Modern Plastics*, vol. 20, August, 1943, pp. 57–60, 144.

36 "Laminating by Low-Pressure Method," by J. D. Nelson, *General Electric Review*, vol. 46, September, 1943, pp. 483–487.

37 "Thermoelastic C-Stage Laminates," by E. F. Lougee, *Modern Plastics*, vol. 20, June, 1943, pp. 69–71, 148.

38 "Post-Forming Thermosetting Products," *Modern Plastics*, vol. 20, August, 1943, pp. 70, 140.

39 "Thermoelastic Forming of Airplane Parts," by W. I. Beach, Mechanical Engineering, vol. 65, 1943, pp. 719–723.

40 "Heating Wood With Radio-Frequency Power," by J. P. Taylor, Trans. A.S.M.E., vol. 65, 1943, pp. 201–212.

41 "Electrostatic High-Frequency Heating Makes Possible Many New Designs," *Product Engineering*, vol. 14, January, 1943, pp. 40–43.

42 "Heatronic Molding," by V. E. Meharg, *Modern Plastics*, vol. 20, March, 1943, pp. 87–90.

43 "Molding With Radio Frequency," by W. M. Witty, *Modern Plastics*, vol. 20, May, 1943, pp. 83–85, 132, 134.

44 "New Application of Heatronic Molding," *Modern Plastics*, vol. 21, November, 1943, pp. 106, 107.

45 "Transfer Molding of Phenolic Material," by C. A. Norris, *Modern Plastics*, vol. 20, April, 1943, pp. 73–78.

46 "Hydraulics in Transfer Molding," by G. W. DeBell, *Modern Plastics*, vol. 20, June, 1943, pp. 88, 89, 148, 150.

47 "Design Suggestions for Molded Phenolics," by Mark Maxwell, *Modern Plastics*, vol. 20, June, 1943, pp. 90–93, 132, 134, 136.

48 "Standard Tolerances of Phenolic and Urea Moldings," by M. Freund, *British Plastics*, vol. 14, April, 1943, pp. 683, 686.

49 "Standard Tolerances," by M. Freund, *British Plastics*, vol. 15, September, 1943, pp. 204–208, 210–212.

50 "Machining Laminated Phenolic Plastics," by F. P. Hunsicker, *Machinery*, vol. 49, December, 1942, pp. 197–200.

51 "Machining Laminated Phenolics," by E. L. Wolfe, *Modern Plastics*, vol. 20, May, 1943, pp. 92, 93, 134, 136, 138.

52 "Sealing by Electronics," *Modern Packaging*, vol. 16, July, 1943, pp. 78, 110.

AIRCRAFT

53 "Low Pressure Laminates for Aircraft," by Powell Crosley, III, *Modern Plastics*, vol. 20, January, 1943, pp. 54,55, 148.

54 "Plastics and Their Application to Aircraft Construction," by J. T. Zhibitsky, *Journal of the Royal Aeronautical Society*, vol. 47, May, 1943, pp. 138–143.

55 "Aircraft Applications of Plastics," by C. L. Fell, *Modern Plastics*, vol. 20, July, 1943, pp. 89, 90, 128.

56 "Engineering Aspects of Plastics," by Henry Sang, *Aero Digest*, vol. 43, August, 1943, pp. 163–165.

57 "Aircraft Design Considerations," by H. R. Gordon, *Modern Plastics*, vol. 21, September, 1943, pp. 101–110, 148, 150, 152.

58 "Industrial Applications of Phenolic Resins," *Modern Plastics*, vol. 21, November, 1943, pp. 84–88, 166, 168.

59 "Formvar Bonds for Airscrews," *Plastics*, vol. 6, December, 1942, pp. 425–427.

60 "Impact-Resistant Aircraft Windshields," by G. L. Pigman, *Modern Plastics*, vol. 20, March, 1943, pp. 107, 150, 152.

61 "New Windshield Developments," by A. L .Morse, *S.A.E. Journal*, vol. 51, August, 1943, pp. 289–293, 304.

62 "An Aircraft Double Windshield," by R. L. McBrien, *S.A.E. Journal*, vol. 51, October, 1943, pp. 350–355.

63 "Transparent Enclosures in Aircraft," by O. E. Brown and W. H. Arata, Jr., *Modern Plastics*, vol. 21, October, 1943, pp. 89–93, 140.

64 "Boxes for Bullets," by C. G. Trimbach, *Modern Plastics*, vol. 20, May, 1943, pp. 59–61.

65 "Unlimited Revolutions for Gun Turrets," *Modern Plastics*, vol. 20, June, 1943, pp. 85–87.

66 "Keep Your Engine Dry," *Modern Plastics*, vol. 20, May, 1943, pp. 89–91, 152.

67 "Engines Have Brains," *Modern Plastics*, vol. 20, July, 1943, pp. 51–54, 138.

68 "Booster Coil Housing," *Modern Plastics*, vol. 21, September, 1943, pp. 96, 97, 144.

69 "Transport Plane Mast," *Modern Plastics*, vol. 20, July, 1943, pp. 57, 58.

70 "Jettison Tanks for Ferry Service," *Modern Plastics*, vol. 21, September, 1943, pp. 75–77, 156.

71 "No Blowouts for Barrage Balloons," *Modern Plastics*, vol. 21, October, 1943, pp. 69–71.

72 "Vertical Speed Indicator," *Modern Plastics*, vol. 21, October, 1943, pp. 100, 148.

73 "The Mustang's Bomb Rack," by Ken West, *Modern Plastics*, vol. 21, November, 1943, pp. 75–77, 170.

74 "Fittings for the Thunderbolt," *Modern Plastics*, vol. 20, June, 1943, pp. 72, 73.

75 "Laminated Aircraft Sub-Assemblies," *Modern Plastics*, vol. 21, September, 1943, pp. 81, 82, 144.

76 "Drop-Hammer and Hydraulic Press Punches," *Modern Plastics*, vol. 20, February, 1943, pp. 68, 69, 130, 132.

77 "Thermoplastics for Aircraft Tools," by J. M. Church, *Modern Plastics*, vol. 20, May, 1943, pp. 74, 75, 140.

78 "Liquid Phenolic Resins for Tooling," by K. J. Leeg, *Modern Plastics*, vol. 20, July, 1943, pp. 65, 66, 134.

79 "Tubing and Tube Fittings," by W. M. White, *Modern Plastics*, vol. 20, August, 1943, pp. 65–67, 150.

80 "Plastics Technical Committees in the U. S.," *Modern Plastics*, vol. 20, August, 1943, pp. 105, 106, 144, 146, 148.

81 "Aircraft From West Coast Timberlands," by C. E. Rozema, *Modern Plastics*, vol. 20, January, 1943, pp. 68, 69, 134, 136.

82 "Plywood in Aircraft Construction," by G. A. Allward, Mechanical Engineering, vol. 65, 1943, pp. 14–16.

83 "Problems in the Use of Plywood in Aircraft Construction," by Alexander Klemin, Mechanical Engineering, vol. 65, 1943, pp. 105–109.

84 "Molded Plastic-Bonded Veneers and Wood in Aircraft Construction," by R. J. Nebesar, Mechanical Engineering, vol. 65, 1943, pp. 197–201; *Modern Plastics*, vol. 20, February, 1943, pp. 83–86, 116.

85 "New War Planes for the United Nations," *Modern Plastics*, vol. 20, March, 1943, pp. 61–69, 152, 154.

86 "Gliders From the Wolverine State," *Modern Plastics*, vol. 20, April, 1943, pp. 62–66, 128.

86(*a*) "Problems in Wood Aircraft," by I. C. Peterson, *S.A.E. Journal*, vol. 51, October, 1943, pp. 369–380.

87 "Problems Affecting the Use of Wood in Aircraft," by R. W. Hess, Mechanical Engineering, vol. 65, September, 1943, pp. 653–656, 660.

88 "Molded Shell Construction in Plywood," by Alexander Klemin, *Aero Digest*, vol. 42, January, 1943, pp. 148, 158, 160, 256, 257.

89 "Seaplane Floats Go to War," *Modern Plastics*, vol. 20, June, 1943, p. 84.

90 "Plywood Refrigerator Cars," *Railway Mechanical Engineer*, vol. 117, August, 1943, pp. 352–355.

91 "Resin-Bonded Plywood Tubing," *Modern Plastics*, vol. 21, October, 1943, pp. 81, 82, 142.

92 "Progress in Aircraft Plywood," by T. D. Perry, *Aeronautical Engineering Review*, vol. 2, February, 1943, pp. 7–16.

93 "Use of Glue in Aircraft Construction," by J. T. Stephan, *Aviation*, vol. 42, March, 1943, pp. 132, 133, 311–320.

94 "Effects of Fire-Retardant Chemicals on Glues Used in Plywood Manufacture," by J. M. Black, Department of Agriculture, Forest Service Report No. R 1427, March, 1943, 25 pp.

95 "Waterproof Glues," by A. G. Night, *Wood*, vol. 7, 1942, pp. 109–112.

96 "The Tegowiro Process," *British Plastics*, vol. 14, February, 1943, pp. 538, 540.

97 "Flexible Pressure in Veneer and Plywood Work," by T. D. Perry, Mechanical Engineering, vol. 65, 1943, pp. 417–424; *Modern Plastics*, vol. 20, August, 1943, pp. 73–77, 130, 132, 134.

98 "High-Frequency Gluing of Resins," by W. Godfrey and P. H. Bilhuber, *Modern Plastics*, vol. 21, September, 1943, pp. 89–93, 154, 156.

99 "Finishes for Plywood in the Aircraft Industry," by R. B. Anderson, Mechanical Engineering, vol. 65, 1943, pp. 506–510.

100 "Behavior of Plywood Under Repeated Stresses," by A. G. H. Dietz and H. Grinsfelder, Trans. A.S.M.E., 65, 1943, pp. 187–191.

101 "Creep in Aircraft Plywood," by J. Delmonte and E. Watkins, *Aero Digest*, vol. 43, July, 1943, pp. 306, 307, 365.

102 "Delamination Tests of Plywood and a Proposed Specification," by C. W. Muhlenbruch, Trans. A.S.M.E., vol. 65, October, 1943, pp. 723–726.

WAR APPLICATIONS

103 "Ordnance Applications of Plastics," by E. T. McBride, *Modern Plastics*, vol. 20, February, 1943, pp. 62, 134.

104 "Plastics in the Quartermaster Corps," by E. L. Hobson, *Modern Plastics*, vol. 20, June, 1943, p. 65.

105 "Automotive Techniques in War," *Modern Plastics*, vol. 21, October, 1943, pp. 72–74, 150–152.

106 "Importance of Ethyl Cellulose," by M. Demarest, W. P. Moeller, and B. E. Cash, *Modern Plastics*, vol. 21, November, 1943, pp. 101–103, 162, 164.

107 "Producing Trench-Mortar Shell Fuses," by W. S. Larson, *Modern Plastics*, vol. 20, January, 1943, pp. 71–73, 146.

108 "Molding a Bomb Recorder Frame," *Modern Plastics*, vol. 20, January, 1943, pp. 75, 76.

109 "Molded Parts for Civilian Gas Mask," *Modern Plastics*, vol. 20, February, 1943, pp. 63–67, 128, 130.

110 "Snake Bite Kit," *Modern Plastics*, vol. 20, February, 1943, pp. 74, 75, 114, 116.

111 "Birth of an Army Canteen," *Modern Plastics*, vol. 20, March, 1943, pp. 71–73.

112 "Wind-Up of the Helmet," *Modern Plastics*, vol. 20, April, 1943, pp. 49–52, 152, 154.

113 "Labels for Leathernecks," *Modern Plastics*, vol. 20, April, 1943, pp. 57, 58, 130, 132.

114 "Fasteners for Army Insignia," *Modern Plastics*, vol. 21, October, 1943, p. 86.

115 "Plastic Hand Grenade and Fuse," *Modern Plastics*, vol. 20, June, 1943, pp. 66, 67.

116 "Army Foot Tubs," by Lee T. Bordner, *Modern Plastics*, vol. 20, June, 1943, pp. 82, 83, 140, 142, 144.

117 "Down-East Handwheels for Destroyers," by W. E. Parsons, *Modern Plastics*, vol. 20, August, 1943, pp. 61, 138, 140.

118 "Navy Training Bayonet," *Modern Plastics*, vol. 21, September, 1943, pp. 70–71, 144.

119 "Signal Corps Microphone," *Modern Plastics*, vol. 21, September, 1943, pp. 72, 73.

120 "The New Army Bugle," *Modern Plastics*, vol. 21, September, 1943, pp. 86, 87, 142.

121 "Eyes of the Tank," *Modern Plastics*, vol. 21, October, 1943, pp. 75–77.

122 "Resin-Bonded Marine Bearings," *Modern Plastics*, vol. 21, November, 1943, pp. 78, 79.

123 "Carrying Cases for Binoculars," by W. R. Bailey, *Modern Plastics*, vol. 21, December, 1943, pp. 75–77.

124 "Replacements for Rubber-Coated Fabrics," by A. F. Schildhauer, *Modern Plastics*, vol. 21, November, 1943, pp. 89–91, 164; also, "Lacquer-Type Fabric Coatings," by Dorman McBurney, *Modern Plastics*, vol. 21, January, 1944.

125 "Steel Shell Case Coating," *Modern Plastics*, vol. 21, September, 1943, pp. 74, 156, 158.

126 "New Coatings Specifications Save Raw Materials," by A. I. Totten, Jr., *Chemical and Engineering News*, vol. 21, March 25, 1943, pp. 370–372.

127 "Extruded Saran Pipe for Industrial Plants," *Modern Plastics*, vol. 20, January, 1943, pp. 60, 132.

128 "Modern Plumbing Fixtures," *Modern Plastics*, vol. 20, March, 1943, pp. 84, 136.

129 "FPHA to Use Plastic Tubing," *Architectural Record*, vol. 93, June, 1943, pp. 80, 94.

130 "Use of Saran for Water Pipes in Buildings and for Service Lines," by F. M. Dawson and A. A. Kalinske, *Journal of the American Water Works Association*, vol. 35, August, 1943, pp. 1058–1064.

131 "Polyvinylidene Chloride as a Moistureproof Film Material," by E. E. Halls, *Plastics*, vol. 7, February, 1943, pp. 74–80.

132 "Permeability of Transparent Wrappings," by C. R. Oswin, *Journal of the Society of Chemical Industry*, vol. 62, April, 1943, pp. 45–48.

133 "Synthetic Flexible Insulation," by A. M. Ross, *General Electric Review*, vol. 46, April, 1943, pp. 212–218.

134 "Substitutes for Sole Leather," by W. Gallay, *Journal of the American Leather Chemical Association*, vol. 38, July, 1943, pp. 250–255.

135 "Demineralizing Solutions by a Two-Step Ion Exchange Process," by H. L. Tiger and S. Sussman, *Industrial and Engineering Chemistry*, vol. 35, February, 1943, pp. 186–192.

136 "Purified Mineral-Free Water for Pharmaceutical Purposes," by J. W. E. Harrisson, R. J. Myers, and D. S. Herr, *Journal of the American Pharmaceutical Association*, Scientific edition, vol. 32, May, 1943 pp. 121–128.

137 "Polyvinyl Acetate Adhesives," by E. E. Halls, *Plastics*, vol. 6, December, 1942, pp. 431–435.

138 "Joining Light Alloys With Adhesives," *Plastics*, vol. 7, May, 1943, pp. 216–218.

139 "Plastics in Medicine," *Scientific American*, July, 1943, p. 22.

140 "Thermosetting Printing Plates," *Modern Plastics*, vol. 20, May, 1943, pp. 67, 68, 128.

141 "Photolithographic Printing Plates," *Modern Plastics*, vol. 20, July, 1943, pp. 62, 63, 126.

142 "Progress in New Synthetic Textile Fibers," by H. R. Mauersberger, *Rayon Textile Monthly*, vol. 24, April, 1943, pp. 181–184.

143 "Refrigerator Cars of Plywood," by H. A. Dodge, *Railway Age*, vol. 114, January 23, 1943, pp. 246–248.

144 "Use of Plastics in Car Construction," *Railway Mechanical Engineer*, vol. 117, July, 1943, pp. 320, 321.

145 "Plastics for the Railroads," *Railway Mechanical Engineer*, vol. 117, October, 1943, pp. 453–455, 459.

146 "Plastics in Assembled Building Structures," by G. Fejer, *Plastics*, vol. 6, November, 1942, pp. 396–407; December, 1942, pp. 444–454; vol. 7, January, 1943, pp. 16–24; February, 1943, pp. 64–70.

147 "Plastics Practically Speaking," by R. F. Marshall, *Architectural Record*, vol. 93, April, 1943, pp. 54–59, 86.

147(*a*) "The Practical Use of Plastics in Building and Constructional Work," by F. S. Snow, A. Caress, and R. J. Schaffer, *Chemistry and Industry*, vol. 62, July 31, 1943, pp. 287–290.

148 "Plastic Spectacle Lenses," by H. H. Emsley, Proc. Physical Society, vol. 55, July, 1943, pp. 314–321.

149 "Plastics and the Optical Industry," by W. G. Wearmouth, Proc. Physical Society, vol. 55, July, 1943, pp. 301–313.

150 "Light-Polarizing Device," by C. D. West (to Polaroid Corp.), U. S. Patent 2,332,958, October 26, 1943.

151 "Polystyrene Aids Electron Microscope," by L. A. Matheson and R. D. Heidenreich, *Modern Plastics*, vol. 21, December, 1943, pp. 124, 125, 160.

152 "Coating by the Electric Spray Method," by H. Ransburg, *Metal Finishing*, vol. 40, November, 1942, pp. 621–623.

153 "Development of the Hot-Spraying of Powdered Materials," by W. E. Ballard, *Chemistry and Industry*, May 22, 1943, pp. 190–194.

154 "Heat Resisting and Stoving Finishes," by R. L. Frost, *Chemistry and Industry*, vol. 62, August 14, 1943, pp. 306–310.

155 "Engineering Fundamentals of Aircraft Finishing," by A. L. Johnson and J. J. Ondhoff, *Aero Digest*, vol. 43, September, 1943, pp. 159, 160, 165, 166, 171–173, 175, 249.

PROPERTIES, TESTING, SPECIFICATIONS

156 "Bearing Strength of Plastics," by James Bond, Trans. A.S.M.E., vol. 65, 1943, pp. 9–14.

157 "Some Mechanical Properties of Plastics and Metals Under Sustained Vibrations," by B. J. Lazan, Trans. A.S.M.E., vol. 65, 1943, pp. 87–104.

158 "Mechanical Tests of Cellulose Acetate," by Wm. N. Findley, Trans. A.S.M.E., vol. 65, 1943, pp. 479–487.

159 "Effects of Continued Heating on Mechanical Properties of Molded Phenolic Plastics," by T. S. Carswell, D. Telfair, and R. U. Haslanger, Trans. A.S.M.E., vol. 65, 1943, pp. 325–328; *Modern Plastics*, vol. 20, February, 1943, pp. 79–82, 126.

160 "Physical Properties of Fiberglas Laminated Plastics," by C. W. Armstrong, *Iron Age*, vol. 152, July 22, 1943, pp. 51–54.

161 "Wood-Cloth and Wood-Paper Laminates," by John Delmonte, Trans. A.S.M.E., vol. 66, 1944, pp. 55–59.

162 "Current Applications and Future Possibilities of Paper-Base Laminates in Aircraft," by C. F. Marschner. Presented at the December, 1943, Annual Meeting of The American Society of Mechanical Engineers.

163 "Plastic Tubings and Fittings," by Wm. M. White. Presented at the December, 1943, Annual Meeting of The American Society of Mechanical Engineers.

164 "Behavior of Phenolic-Resin-Bonded Plywood Under Alternating Stresses," by A. G. H. Dietz and H. Grinsfelder. Presented at the December, 1943, Annual Meeting of The American Society of Mechanical Engineers.

165 "Creep Properties of Molded Phenolic Plastics," by D. Telfair, T. S. Carswell, and H. K. Nason, *Modern Plastics*, vol. 21, Feb., 1944, pp. 137–144, 174, 176. Presented at the December, 1943, Annual Meeting of The American Society of Mechanical Engineers.

166 "Plastic Printing Plates," by Wm. R. McLain. Presented at the December, 1943, Annual Meeting of The American Society of Mechanical Engineers.

167 "Anti-Scatter Treatments for Glass," by F. W. Reinhart, Ruth Kronstadt, and G. M. Kline. Presented at the December 1943, Annual Meeting of The American Society of Mechanical Engineers.

168 "Impact Testing of Plastics. I—Energy Considerations," by D. Telfair and H. K. Nason, *Modern Plastics*, vol. 20, July, 1943, pp. 85–88.

169 "Deformation Under Load of Rigid Plastics," by Robert Burns, *Modern Plastics*, vol. 21, September, 1943, pp. 111, 112.

170 "Relation Between Repeated Impact and Fatigue Tests," by W. N. Findley and O. E. Hintz, Jr., *Modern Plastics*, vol. 21, December, 1943, pp. 119–123.

171 "Engineering Properties of Plastics," by F. B. Fuller, *Modern Plastics*, vol. 20, June, 1943, pp. 95–97, 130.

172 "Basic Physical Properties of Laminates," by P. M. Field, *Modern Plastics*, vol. 20, August, 1943, pp. 91–102, 126, 128, 130.

173 "Fatigue Characteristics of Natural and Resin-Impregnated, Compressed, Laminated Woods," by F. B. Fuller and T. T. Oberg, *Journal of the Aeronautical Sciences*, vol. 10, March, 1943, pp. 81–85.

174 "Mechanical Properties of Plastics at Normal and Subnormal Temperatures," by T. P. Oberg, R. T. Schwartz, and D. A. Shinn, *Modern Plastics*, vol. 20, April, 1943, pp. 87–100, 122, 124, 126, 128.

175 "Evaluation of High-Strength Plastics," by H. Sang and P. M. Field, *Modern Plastics*, vol. 21, October, 1943, pp. 107–109, 142.

176 "Fatigue Resistance of Flexible Plastic Sheeting," by F. W. Duggan and K. K. Fligor, *Industrial and Engineering Chemistry*, vol. 35, February, 1943, pp. 172–176.

177 "Abrasion Resistance of Flexible Vinyl Plastics," by F. W. Duggan, *Product Engineering*, vol. 14, January, 1943, pp. 45–49.

178 "Stress-Strain Characteristics of Vinyl Elastomers," by M. C. Reed, *Industrial and Engineering Chemistry*, 35, April, 1943, pp. 429–431.

179 "Bend-Brittle and Shatter Points of Rubberlike Materials," by G. E. King, *Industrial and Engineering Chemistry*, vol. 35, 1943, p. 949.

180 "Effect of Cure on the Properties of Urea-Formaldehyde Moldings," by J. Hofton, *British Plastics*, November, 1942, pp. 350–352.

181 "Effect of Conditioning Upon Some Physical Properties of Urea-Formaldehyde Moldings," by J. Hofton, *British Plastics*, vol. 14, December, 1942, pp. 377–380.

182 "Chemical Resistance of Laminates," by C. J. Straka, *Modern Plastics*, vol. 20, July, 1943, pp. 80–84, 136, 138.

183 "Properties of Laminated Phenolics," by L. E. Caldwell, *Modern Plastics*, vol. 20, August, 1943, pp. 82–87, 138.

184 "Strength and Properties of Plexiglas," by W. F. Bartoe, *Aviation*, vol. 42, January, 1943, pp. 128–131, 135.

185 "Mechanical Properties of Plastics at Low Temperatures," *Plastics*, vol. 6, December, 1942, pp. 439–442.

186 "Ignition Points of Plastic Materials," by J. Delmonte and M. A. Azam, *Modern Plastics*, vol. 20, February, 1943, pp. 88, 122, 124.

187 "Electrical Application of New Thermoplastics," by T. S. Carswell and T. Alfrey, *Electrical World*, vol. 112, June 12, 1943, pp. 1951–1953.

188 "Toughness of Molding Materials," by Thomas Hazen, *Modern Plastics*, vol. 21, October, 1943, pp. 103–106, 144.

189 "A Schematic Procedure for Identification of Common Commercial Plastics," by H. Nechamkin, *Industrial and Engineering Chemistry*, Analytical edition, vol. 14, January, 1943, pp. 40, 41.

190 "Identification of Plastics," Plastics Catalog, 1944, Plastics Catalogue Corporation, New York, N. Y.

191 "Identification of Plywood Glues," by B. J. Rendle and G. L. Franklin, *Journal of the Society of Chemical Industry*, vol. 62, 1943, pp. 11–14.

BOOKS

192 "Techanical Data on Plastic Materials," Washington: Plastic Materials Manufacturers' Association, 1943.

193 "Manual on Assembly Gluing," Society of the Plastics Industry, New York, N. Y., 1943.

194 "Extruded Plastic Tubing and Shapes," Society of the Plastics Industry, New York, N. Y., 1943.

195 "A.S.T.M. Standards on Plastics," American Society for Testing Materials, Philadelphia, Pa., 1943.

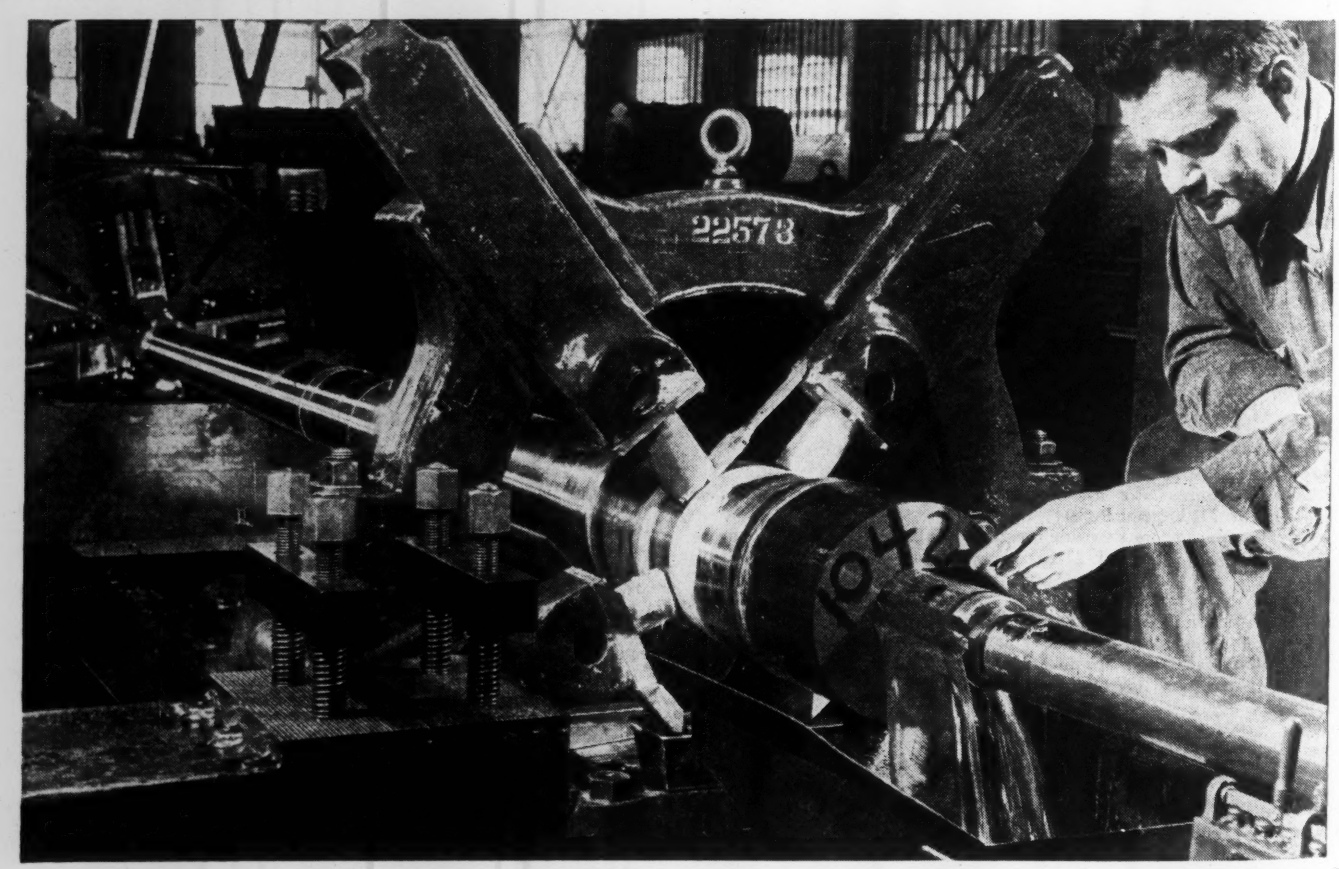
196 "The Chemistry of Large Molecules," by R. E. Burk and Oliver Grummitt, editors, Interscience Publishers, Inc., New York, N. Y., 1943.

197 "Cellulose and Cellulose Derivatives," by Emil Ott, editor, Interscience Publishers, Inc., New York, N. Y., 1943.

198 "Plastics From Farm and Forest," by E. F. Lougee, Plastics Institute, Chicago, Ill., 1943.

199 "Handbook of Plastics," by H. R. Simonds and Carleton Ellis, D. Van Nostrand Company, Inc., New York, N. Y., 1943.

200 "Plastics Catalog 1944," Plastics Catalogue Corporation, New York, N. Y.



MACHINING ANTIAIRCRAFT GUN

(The tool in the foreground is cutting the loading chamber in the breech of a barrel for an antiaircraft gun. This is one of the first steps in processing the barrel before assembly on an antiaircraft gun mount at the Naval Ordnance Plant operated by the Westinghouse Electric and Manufacturing Company.)

ADVANCES *in* RUBBER *During* 1943

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WAR censorship has kept information on many of the technological advances, made in 1943, from public knowledge. Paradoxically, however, one of the greatest of these advances is an achievement unparalleled in the nation's industrial history which was so successful that widespread publicity, rather than secrecy, has been the rule. The Baruch report (1)[1] dated September 10, 1942, disclosed among other things the fact that unless seemingly impossible quantities of synthetic rubber were produced during 1943, the entire course of the war might easily be altered.

Some privately financed and government-owned synthetic-rubber plants were already in production at the time of the release of the Baruch report, though the total amount of synthetic rubbers of all types actually being produced was probably under a rate of 50,000 tons per year. Extensive plans too had been made for the building of huge plants, at the time of the release of the report. A "standard design" copolymer plant with an annual capacity of 30,000 tons had been established, based on experiences gained in the plants already in production. A sufficient number of these standard plants to produce the required total amount of synthetic rubber was then scheduled, and construction on some of these was begun as early as September, 1942. Announcements of the completion dates of these and related butadiene and styrene plants began to appear early and continued throughout the year (2, 3, 4, 5, 6, 7, 8, 9, 10). The largest of the copolymer plants (10) is scheduled to produce GR-S at the rate of 120,000 long tons annually. This is equivalent to approximately 600,000 acres of rubber plantation, each acre of which has about 120 trees, each tree requiring 150 tappings per year.

The latest available public report on production of synthetic rubber was given by Col. Bradley Dewey at the 106th meeting of the American Chemical Society held in Pittsburgh, Pa., September 6 to 10, 1943. It was reported there that two thirds of the annual scheduled production of 850,000 long tons of synthetic rubbers had already been completed, and that there was every assurance that all the plants would be in operation by the end of the year. Thus this nation, near the end of 1943, is already past the danger it once faced of complete collapse of both military and domestic fronts caused by the lack of an adequate supply of "rubber."

A NOTABLE RECORD OF ACHIEVEMENT

The credit for this splendid record of achievement must be shared by research scientists of the rubber, petroleum, and alcohol industries and a large group of chemical, construction, design, and mechanical engineers. As a result of the combined efforts of these groups, this country has been able to design, construct, and put into production, within a time of about 2 years, plants for the manufacture of synthetic rubbers at an annual rate which greatly exceeds our normal, over-all consumption of natural rubber in any year previous to the war. That this truly remarkable achievement has been recognized is evidenced by the fact that the American synthetic-rubber industry is to receive the 1943 Award for Chemical Engineering Achievement.

Although the primary problem of obtaining an ample supply of rubber was solved in 1943, many other problems have not been so fortunately concluded. Man-power shortages, shortages of manufacturing equipment, and manufacturing capacity are some of the unsolved problems outside of the scope of this report which make conservation of manufactured rubber goods (particularly passenger-car tires) mandatory in spite of the present adequacy of supply of raw synthetic rubber. Still other problems have been the object of many intensive researches, only a few of which, however, have been published.

CHEMURGIC RUBBER SUBSTITUTES

The search for natural-rubber substitutes other than GR-S continued during 1943. The commercial production of Agripol, a synthetic rubber-like material was announced late in 1942 (11). This material is one of a class of "chemurgic rubbers" such as Norepol, Vulprene, and Sulprene which are essentially derivatives of fatty oils. An excellent article giving the properties, uses, limitations, etc., of this type of synthetic rubber has been published (12). Other chemurgic rubbers introduced are Kem-Pol (13) and Witcogum (14). It is claimed that no critical chemicals or equipment are used in the manufacture of the latter two, but like the others they can only be considered a substitute for rubber in applications where low elongation and low tensile properties can be tolerated.

An interesting new development was revealed in the announcement (15) that sponge rubber could be produced from some of these chemurgic rubbers. Although inferior to natural-rubber sponge in flexibility and compressibility at normal temperatures, it is claimed to be superior in these properties at low temperatures. A somewhat different polyester rubber named Paracon was also developed and is in limited production as a specialty rubber (16, 17). The tensile and elongation of Paracon are reported to be higher than those of the other chemurgic rubbers mentioned, though no details have been released as to the maximum attainable values of these properties.

WIDE RANGE OF NONCHEMURGIC SUBSTITUTES DEVELOPED

A considerable number of nonchemurgic rubber substitutes were also introduced. Although some of these products do not even possess the principal characteristic properties of rubber (high extensibility and tensile strength), their use wherever possible resulted in the saving of a considerable quantity of natural rubber. Among these might be mentioned: Bubbelfil (18), an interesting substitute for sponge rubber or Kapok, made of cellophane; Haydenite (19), a plastic coating material for raincoats having a polyvinyl-butyral base; wool felt (20); cattle-hair felt (21); a shock-absorbent material used for padding the interior of tanks; Styraloy (22), a synthetic hydrocarbon elastomer said to possess excellent low-temperature flexibility and electrical properties; Synflex FT-11 (23); and Marvinol (24), a thermoplastic material reported to be completely reclaimable and to have excellent air-retention proper-

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[1] Numbers in parentheses refer to the Bibliography at the end of the paper.

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ties which make it superior to natural rubber for use in inner tubes.

In the field of adhesives, bonding materials, and tank linings, many of the rubber "substitutes" are proving vastly superior to the natural material. Cycleweld (25) and Reanite (26), bonding processes based on the use of synthetic materials, are reported to produce higher-strength bonds between materials of a more diverse nature than had previously been found possible with natural rubber. Substitution of this type of bonding for riveting in certain aircraft and tank applications results in a large saving in man-hours and material. The postwar possibilities of this significant advance appear almost unlimited. Details of the Redux bonding process (27), announced by the British, are being kept secret and are available only to those engaged in essential war work. A new adhesive to replace rubber has been announced (28) for use on masking paper. The results of extensive tests on synthetic-rubber cements have been published (29, 30).

Literally scores of materials were introduced to the rubber industry, especially in the early months of 1943, as means of overcoming some of the shortcomings of GR-S (low plasticity, low tack) or to "extend" the limited supplies of both GR-S and natural rubber. All of these materials were reportedly made of noncritical chemicals; some served double purposes such as plasticizer and tackifier or tackifier-extender, etc. Typical of such materials are: Turgum (31), plasticizer and tackifier; Falkomer (32), extender and plasticizer; Synthol (33), tackifier and plasticizer; Plastac (34), processing aid; Galex (35), plasticizer; Thiokol TP-90 (36), a low-temperature plasticizer; Syntac (37), plasticizer; Plastender (38), a reinforcing-type plasticizer; Estac (39), tack-producing plasticizer; Polymel (40), plasticizer, softener, extender, and general processing aid; Norab (41), extender; Oroplasts (42), plasticizer and extender; and JMH (43), peptizer for GR-S. The evaluation of this long (though necessarily incomplete) list of materials imposed a serious burden on the testing facilities of the rubber industry, and particularly those of the smaller rubber manufacturers. It is expected that, as the supply of GR-S increases, the necessity for using some of these materials (especially the "extender") will decrease proportionately.

LINING FOR CONCRETE GASOLINE TANKS

A significant advance in tank linings was marked by the announcement of synthetic-rubber linings for concrete gasoline tanks (44, 45). The use of this lining overcomes the tendency of the concrete to crack, allowing the gasoline to escape, and also prevents the gasoline (particularly high-octane fuel) from the deterioration which would result from direct contact with concrete. Conservation of steel, vitally important in 1943, was thus effected, and underground concrete tanks became practicable, an obvious advantage for storage at military depots. Another specialty lining announced was Synflow (46).

Although some of the synthetic rubbers, and particularly GR-S, are quite similar to the natural-rubber products, nevertheless some very fundamental differences in physical properties and chemical reactions exist. The effects of various pigments, concentration of pigments, sulphur content, type and amounts of accelerator, antioxidant, softener, activators, etc., on natural-rubber vulcanizates all had been thoroughly investigated in continuing researches extending over a period of a number of years. The high state of excellence of the many rubber products was a direct result of the full use of this large fund of information. If the best possible products were to be made from the substitute raw materials, it was imperative that a similar fund of data be accumulated quickly.

Intensive researches were begun and a vast amount of information was freely interchanged at industry-wide committee meetings. Much the largest share of this information was never published in the literature, but was simply handed out to the industry representatives at the various meetings, in the form of mimeographed, confidential reports. As a result of this action, full use of all existing test facilities was made to advance synthetic-rubber technology speedily to a high degree during the year 1943. A number of significant papers were published, supplementing the data distributed through committees. These include articles on accelerators (47); sulphur behavior in GR-S, contrasted with that in natural rubber (48); blending of various synthetics (49, 50); compounding of GR-S (51); of Guayule rubber (52, 53, 54, 55); of Butyl rubber (56); manufacturing and processing of synthetic rubbers (57, 58); the effects of various carbon blacks on the various synthetics (59, 60, 61, 62); synthetic cable insulation (63, 64, 65, 66, 67, 68); zinc oxide as a pigment (69); and densities of synthetics (70).

TESTING PROPERTIES OF SYNTHETICS

Similar significant advances have been made in the field of measurement of physical properties of synthetics. New techniques have been developed for the measurement of cut growth (71), heat generation (72), swelling (73), resilience (74), and flex-cracking (75). The tear resistance of GR-S vulcanizates after coming into contact with petroleum products has also been investigated (76).

In general, each of the synthetics excells in some one (or more) characteristic property. Papers illustrating such unique properties (77, 78) have assisted the technologist in choosing a particular type of synthetic rubber for a given specialty application.

New uses for semiconducting rubber (commercially used for the first time in reducing or eliminating static shock on passenger buses) are being found almost daily. Its most recent application is in a new type of deicing device (79). In addition to the unpublished committee reports on this subject, excellent papers on the effect of carbon-black particle size on conductivity (80) and the conducting properties of Neoprene (81) were published in 1943.

The physical and mechanical properties of rubber at low temperatures have been the subjects of laboratory investigations for a number of years, although no satisfactory test or evaluation technique had been developed. The substitution of synthetics (some of which became hard or even brittle at relatively high temperatures) in combat vehicles for natural rubber made it necessary to develop new ways of evaluating the low-temperature properties of all the elastomers. Descriptions of a number of test techniques were published (82, 83, 84, 85, 86, 87, 88, 89, 90), testifying to the importance of this phase of rubber technology in the war effort and to the extremely rapid advances effected. Additional descriptions of new tests were disclosed in papers presented at the fall meeting of the Division of Rubber Chemistry of the American Chemical Society.[2]

SEARCH FOR GOOD PASSENGER-CAR TIRE CONTINUES

Although the need for passenger-car tire replacements is still great, the disappointing results of the extensive 1942 search for an "interim tire" left almost no hope for even a partially good solution in 1943. A suggestion for reclaiming millions of passenger-car inner tubes was made near the beginning of 1943 (91), but apparently the disadvantages of tubeless-tire operation outweighed the advantages to be gained by adding these millions of tubes to the already huge unprocessed scrap-rubber piles, so that no action was taken by the authorities. A carpet-like material impregnated with asphalt has been proposed as a recap for certain light-duty service applications (92). A new "carpet pile" retread has been announced recently (93), but as yet no official decision has been made as to whether or not allocations will be made to produce them in sufficient quantity.

FEW WAR APPLICATIONS ANNOUNCED

Only a few of the undoubtedly large number of rubber or synthetic products made for the armed forces have been made public. A new lifesaving suit, employing an interesting all-rubber interlocking zipper has been described (94). An improvement in the efficiency of the self-sealing fuel tanks now being used on certain types of warplanes is reported to have been effected through the use of glass cloth (95). The blanket of glass cloth is said to prevent "flowering" of the metal into the rubbery self-sealing material of the tanks. Three new airplane tires introduced in 1943 (96, 97, 98) are reported to resist skidding on icy runways, thus aiding pilots operating under winter conditions. Reports on war materials from foreign countries too are meager and can only suggest the progress and advances made there. To a new "camel-tread" sand tire is ascribed part of the success of the British Eighth Army in defeating Rommel in Africa (99). Results of tests on Kok-Saghyz tires, started in 1933, have just begun to be reported (100).

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[2] Abstracts appear in *Rubber Age*, vol. 53, Sept., 1943, p. 523.

INVESTIGATION OF OTHER SOURCES FOR SUBSTITUTES

Although the principal stress has been placed on GR-S production as a source of rubber in quantity, investigations of other sources were continued in 1943. Accurate data on the progress and present state of development are extremely difficult to obtain. However, it is known that extensive plantings of the Cryptostegia vine have been made in Haiti and tapping by a new high-production technique is reported to have begun (101, 102, 103). An ultimate production of 12,000 tons per year (after completion of the proposed program of 100,000 acres under cultivation), is predicted, though 1943 production was only a fraction of this quantity. Substantial cultivation of Hevea brasiliensis has also been started in Haiti, Brazil, Panama, Ecuador, and Columbia. A tremendous amount of effort is being expended to develop these sources even though no appreciable amounts of rubber can be expected for a number of years at best.

Vigorous efforts to organize collection of wild rubber in the Latin-American regions have also been pursued (104, 105). The total amount thus collected is difficult to estimate, but even though only a fraction of our total needs, it is an important contribution in view of the desirability of using some natural rubber blended with GR-S in heavy-duty tires. The Guayule situation has not been definitely settled as yet. With the completion of the synthetic-rubber program very nearly accomplished, expansion of the Guayule program is now being urged (106). Another native plant, the Jojoba nut, is reported to yield a rubber-like material of some interest (107).

CRUDE RUBBER ESTIMATED AT 180,000 TONS

One of the most recent estimates of the total availability of crude rubber places the amount at 180,000 tons per year (101). Of this amount, 110,000 tons were reported to be coming from Ceylon, 40,000 tons from the Western Hemisphere, and 30,000 tons from Africa. The total Liberian production (estimated at 14,000 tons annually) was said to be going to the United States. Several other interesting articles on the subject of rubber in tropical America, some of them dealing also with postwar prospects, have been published (108, 109, 110, 111, 112, 113).

PROGRESS A MATTER OF INTENSIVE RESEARCH

No report of this nature would be complete without mention of the enormous amount of chemical and physical research which, though largely unpublished, contributed so markedly to the successful solution of our rubber-supply problem in 1943. The relatively few papers published on emulsifying agents, detergents, etc. (114, 115, 116), new or improved methods of chemical analysis (117, 118), and high-polymers studies (119, 120) can only serve as indications of the direction in which chemical technology is progressing. In the field of physical analysis too, increasing use was made of older tools such as the X-ray diffraction apparatus (121) and the infrared spectroscope (122). One of the newest and most widely publicized research tools, the electron microscope, was also extensively employed (123), although details are almost completely lacking.

New methods for the production of raw materials in large quantities (principally butadiene and styrene) based on the use of both chemurgic (grain alcohol) and petroleum products were found and are described in the literature (124, 125, 126, 127, 128). An important symposium on a subject vital to synthetic-rubber manufacture, i.e., reaction rates, in which the theories and practical knowledge of some of the nation's best minds played prominent parts, was held during 1943 (129).

The rayon-cotton tire-cord controversy has continued to be a bitterly discussed point (130), but Wm. M. Jeffers' initial stand has been consistently supported, hence rayon is still being employed almost exclusively in heavy-duty synthetic tires for the armed services. Progress reports (131, 132), issued by the Rubber Director, kept the nation informed during the year on one of the most critical situations of the war. There is little doubt that these reports, based on frankness and a high degree of accuracy, had much to do with the wholehearted co-operation of the country in the emergency. A somewhat less widely circulated but none the less interesting "report" was the Charles Goodyear Memorial Lecture, "The Second Mile," given in 1943 by L. B. Sebrell (133).

BIBLIOGRAPHY

1 "Report of the Rubber Survey Committee, September 10, 1942," by James B. Conant, Karl T. Compton, and Bernard M. Baruch.

2 "The Government Synthetic Rubber Plant at Institute, W. Va.—I," by R. G. Seaman, *India Rubber World*, vol. 108, July, 1943, p. 359.

3 "The Government Synthetic Rubber Plant at Institute, W. Va.—II," by R. G. Seaman, *India Rubber World*, vol. 108, August, 1943, p. 457.

4 "Baton Rouge—Symbol and by Forecast," *Petroleum Refiner*, vol. 22, July, 1943, p. 115.

5 "Synthetic Rubber Program Shaping Up to Assure Capacity Operation This Year," *Petroleum Refiner*, vol. 22, July, 1943, p. 134.

6 "Government-Owned Synthetic Plant at Baytown Now in Operation," *Rubber Age*, vol. 53, July, 1943, p. 344.

7 "Government-Owned Plant Operated by Firestone Now in Complete Operation," *Rubber Age*, vol. 53, July, 1943, p. 345.

8 "Synthetic Rubber Program Rapidly Nears Successful Completion," *Rubber Age*, vol. 53, September, 1943, p. 535.

9 "Monsanto's Styrene Plant in Texas Rapidly Nears Completion," *Rubber Age*, vol. 53, June, 1943, p. 251.

10 "Largest Synthetic Plant Opened," *India Rubber World*, vol. 108, September, 1943, p. 575.

11 "Agripol," *Rubber Age*, vol. 52, December, 1942, p. 243.

12 "Rubber Substitutes From Fatty Oils," by R. T. Nazarro and W. Abramowitz, *Rubber Age*, vol. 52, March, 1943, p. 483.

13 "Kem-Pol—Properties, Characteristics and Applications," by W. T. Walton, *Rubber Age*, vol. 53, June, 1943, p. 234.

14 "Witcogum—New Type Chemurgic Rubber," by C. S. Yoran and W. I. Harbor, *India Rubber World*, vol. 108, April, 1943, p. 43.

15 "Substitute for Sponge Rubber," *India Rubber World*, vol. 107, January, 1943, p. 395.

16 "Paracon—A Specialty Rubber," *Rubber Age*, vol. 53, May, 1943, p. 138.

17 "Additional Data on Paracon Rubber," *Rubber Age*, vol. 53, August, 1943, p. 441.

18 "Bubblefil," *India Rubber World*, vol. 107, November, 1942, p. 179.

19 "Haydenite Replaces Rubber in Army Raincoats," *India Rubber World*, vol. 107, December, 1942, p. 279.

20 "Wool Felt as a Substitute for Rubber," by W. Colwell, *Rubber Age*, vol. 53, May, 1943, p. 136.

21 "New Shock-Absorbent Material," *India Rubber World*, vol. 107, January, 1943, p. 393.

22 "Styraloy 22—A New Synthetic Elastomer," *Rubber Age*, vol. 53, April, 1943, p. 46.

23 "New Flexible Tubing," *India Rubber World*, vol. 108, September, 1943, p. 573.

24 "Marvinol—New Elasto-Plastic," *Rubber Age*, vol. 53, September, 1943, p. 529.

25 "Cyclewelding Applied Successfully to Airplane Subassemblies," *Automotive and Aviation Industries*, vol. 89, October 1, 1943, p. 33.

26 "Reanite Bonding Process," *Rubber Age*, vol. 53, August, 1943, p. 426.

27 "The Redux Process," *India Rubber World*, vol. 109, October, 1943, p. 84.

28 "New du Pont Adhesive Replaces Rubber in Special Applications," *Rubber Age*, vol. 53, June, 1943, p. 253.

29 "Synthetic Rubber Cements—I," by D. V. Sarbach, *India Rubber World*, vol. 108, June, 1943, p. 249.

30 "Synthetic Rubber Cements—II," by D. V. Sarbach, *India Rubber World*, vol. 108, July, 1943, p. 363.

31 "Turgum—Plasticizer and Tackifier," *Rubber Age*, vol. 53, April, 1943, p. 55.

32 "Falkomer—New Extender for Buna-Type Synthetic Rubber," *Rubber Age*, vol. 52, February, 1943, p. 409.

33 "Synthol-Tackifier and Plasticizer," *Rubber Age*, vol. 53, June, 1943, p. 264.

34 "Plastac—A Processing Aid for Butadiene-Type Rubbers," *Rubber Age*, vol. 52, March, 1943, p. 498.

35 "Galex as a Plasticizer for GR-S (Buna S) Stocks," by J. Panek, *Rubber Age*, vol. 53, April, 1943, p. 35.

36 "Thiokol TP-90—A Low Temperature Plasticizer," *Rubber Age*, vol. 53, April, 1943, p. 34.

37 "Syn-Tac"—A New Plasticizer," *Rubber Age*, vol. 53, April, 1943, p. 56.

38 "Reinforcing-Type Plasticizers," *Rubber Age*, vol. 53, May, 1943, p. 171.

39 "New Tack-Producing Plasticizer," *Rubber Age*, vol. 53, June, 1943, p. 252.

40 "Polymel—A New Compounding Aid," *Rubber Age*, vol. 53, July, 1943, p. 355.

41 "Rubber Extender Announced," *India Rubber World*, vol. 108, August, 1943, p. 481.

42 "Oroplasts for Natural and Synthetic Rubbers," *India Rubber World*, vol. 108, September, 1943, p. 583.

43 "New Chemicals for GR-S," *India Rubber World*, vol. 108, September, 1943, p. 583.

44 "Sheet Linings of Synthetic Rubber for Gasoline Tanks," *National Petroleum News*, Tech. Sec., vol. 35, May 5, 1943, p. R-200.

45 "Concrete Tanks, Leak-Proofed for Gasoline Storage With Synthetic Rubber Latex," *National Petroleum News*, Tech. Sec., vol. 35, October 6, 1943, p. R-446.

46 "Synflow Lining," *Rubber Age*, vol. 52, February, 1943, p. 436.

47 "The Use of Accelerators in Buna S," by A. M. Neal, *Rubber Age*, vol. 53, April, 1943, p. 31.

48 "Simple Vulcanizates of Buna S and Sulphur," by L. E. Cheyney, *Industrial and Engineering Chemistry*, vol. 35, September, 1943, p. 976.

49 "Blends of Thiokol FA With Neoprene GN, Hycar OR-15, and Perbunan 26," by S. M. Martin, Jr., and E. A. Laurence, *Industrial and Engineering Chemistry*, vol. 35, September, 1943, p. 986.

50 "The Effects of Blending Guayule Rubber With GR-S," by R. E. Morris, A. E. Barrett, W. B. Lew, and T. A. Werkenthin, *India Rubber World*, vol. 109, November, 1943, p. 150.

51 "Compounding Adjustments for Controlling the Variability of GR-S," by G. R. Vila and F. L. Holbrook, *India Rubber World*, vol. 109, October, 1943, p. 37.

52 "The Compounding of Guayule Rubbers," by R. E. Morris, R. R. James, and T. A. Werkenthin, *India Rubber World*, vol. 107, October, 1942, p. 31.

53 "The Compounding of Guayule Rubbers," by R. E. Morris, R. R. James, E. B. Caldwell, and T. A. Werkenthin, *India Rubber World*, vol. 107, February, 1943, p. 463.

54 "Studies in Compounding Guayule Rubber—II," by E. A. Hauser and D. S. le Beau, *India Rubber World*, vol. 107, March, 1943, p. 568.

55 "Studies in Compounding Guayule Rubber—III," by E. A. Hauser and D. S. le Beau, *India Rubber World*, vol. 108, April, 1943, p. 37.

56 "Butyl Rubber Properties and Compounding," by J. P. Haworth and F. P. Baldwin, *Industrial and Engineering Chemistry*, vol. 34, 1942, p. 1301.

57 "Manufacturing and Processing of Buna-Type Synthetic Rubbers," by H. J. Mueller, *India Rubber World*, vol. 107, October, 1942, p. 33.

58 "Butyl Rubber Production, Unique American Development," by J. A. Lee, *Chemical & Metallurgical Engineering*, vol. 50, July, 1943, p. 102.

59 "Study of Carbon Blacks in Natural and Synthetic Rubber—I," by I. Drogin, *India Rubber World*, vol. 106, September, 1942, p. 561.

60 "Study of Carbon Blacks in Natural and Synthetic Rubber—II," by I. Drogin, *India Rubber World*, vol. 107, October, 1942, p. 42.

61 "Study of Carbon Blacks in Natural and Synthetic Rubber—III," by I. Drogin, *India Rubber World*, vol. 107, December, 1942, p. 272.

62 "Carbon Black in Butyl Rubber," by L. B. Turner, J. P. Haworth, W. C. Smith, and R. L. Zapp, *Industrial and Engineering Chemistry*, vol. 35, September, 1943, p. 958.

63 "Electric Cable Insulation From Synthetic Rubbers—I," by S. E. McCrary, R. P. Metcalf, J. B. Lunsford, H. K. Graves, T. A. Werkenthin, R. E. Morris, and R. R. James, *India Rubber World*, vol. 107, November, 1942, p. 157.

64 "Electric Cable Insulation From Synthetic Rubbers—II," by S. E. McCrary, R. P. Metcalf, J. B. Lunsford, H. K. Graves, T. A. Werkenthin, R. E. Morris, and R. R. James, *India Rubber World*, vol. 107, December, 1942, p. 265.

65 "Electrical and Mechanical Properties of the System Buna S—Gilsonite," by A. H. Selker, A. H. Scott, and A. T. McPherson, *Journal of Research*, National Bureau of Standards, vol. 31, September, 1943, p. 141.

66 "Synthetic Flexible Insulation," by A. M. Ross, *General Electric Review*, vol. 46, April, 1943, p. 212.

67 "Electric Cable Insulation From Synthetic Rubbers—I," by S. E. McCrary, R. P. Metcalf, J. B. Lunsford, H. K. Graves, T. A. Werkenthin, R. E. Morris, and R. R. James, *India Rubber World*, vol. 107, November, 1942, p. 157.

68 "Electric Cable Insulation From Synthetic Rubbers—II," by S. E. McCrary, R. P. Metcalf, J. B. Lunsford, H. K. Graves, T. A. Werkenthin, R. E. Morris, and R. R. James, *India Rubber World*, vol. 107, December, 1942, p. 265.

69 "The Role of Zinc Oxide in Compounding Government Synthetic Rubber," by R. S. Havenhill and J. J. Rankin, *India Rubber World*, vol. 107, January, 1943, p. 365.

70 "Measurement of Densities of Synthetic Rubbers," by L. A. Wood, N. Bekkedahl, and F. L. Roth, *Journal of Research*, National Bureau of Standards, vol. 29, December, 1942, p. 391.

71 "Cut Growth of Buna S Compounds," by C. A. Carlton and E. B. Reinbold, *India Rubber World*, vol. 108, May, 1943, p. 141.

72 "Heat Generation in Flexed Rubber," by S. D. Gehman, P. J. Jones, and D. E. Woodford, *Industrial and Engineering Chemistry*, vol. 35, September, 1943, p. 964.

73 "Effect of Petroleum Products on Neoprene Vulcanizates," by D. F. Fraser, *Industrial and Engineering Chemistry*, vol. 35, September, 1943, p. 947.

74 "Effect of Temperature on Resilience of Natural and Synthetic Rubber," by H. C. Jones and E. G. Snyder, *India Rubber World*, vol. 108, May, 1943, p. 137.

75 "Some Observations on the Flex-Cracking Characteristics of GR-S (Buna S) Compounds," by Joseph Breckley, *Rubber Age*, vol. 53, July, 1943, p. 331.

76 "The Effect of Petroleum Products on Buna S Vulcanizates," by R. E. Morris, P. Mitton, J. C. Montermoso, and T. A. Werkenthin, *Industrial and Engineering Chemistry*, vol. 35, June, 1943, p. 646.

77 "Heat Resistance of Neoprene GN Vulcanizates," by D. B. Forman, *Industrial and Engineering Chemistry*, vol. 35, September, 1943, p. 952.

78 "Hycar OR-25—A New Polymeric Hydrocarbon," by D. E. Sausser, *Rubber Age*, vol. 53, April, 1943, p. 42.

79 "New Anti-Icing Device," *Rubber Age*, vol. 53, September, 1943, p. 549.

80 "Conductivity of Rubber Tread Stocks," by L. H. Cohan and J. F. Mackay, *Industrial and Engineering Chemistry*, vol. 35, July, 1943, p. 806.

81 "Electrical Properties of Neoprene," by F. L. Yerzley, *Industrial and Engineering Chemistry*, vol. 35, March, 1943, p. 330.

82 "A Method of Testing the Elasticity of Synthetic Rubbers at Low Temperatures," by G. D. Kish, *Rubber Age*, vol. 53, May, 1943, p. 131.

83 "A Tensiometer Stiffness Test for Elastomers at Low Temperatures," by B. K. Green, R. G. Cholar, and G. J. Wilson, *Rubber Age*, vol. 53, July, 1943, p. 319.

84 "Evaluating Low-Temperature Stiffness and Brittle Point in Elastomers," by F. L. Graves and A. R. Davis, *India Rubber World*, vol. 109, October, 1943, p. 41.

85 "Thiokol's Freeze Test Adopted," *India Rubber World*, vol. 107, January, 1943, p. 392.

86 "The Effect of Petroleum Solvents on the Cold Resistance of Synthetic Vulcanizates," by R. E. Morris, R. R. James, E. H. Berger, and T. A. Werkenthin, *India Rubber World*, vol. 108, September, 1943, p. 553.

87 "Brittle Temperature of Rubber Under Variable Stress," by A. R. Kemp, F. S. Malm, and G. G. Winspear, *Industrial and Engineering Chemistry*, vol. 35, April, 1943, p. 488.

88 "Brittle Points of Natural and Synthetic Rubber Stocks," by R. E. Morris, R. R. James, and T. A. Werkenthin, *Industrial and Engineering Chemistry*, vol. 35, August, 1943, p. 864.

89 "Bend-Brittle and Shatter Points of Rubber-Like Materials," by G. E. King, *Industrial and Engineering Chemistry*, vol. 35, September, 1943, p. 949.

90 "Evaluating Low-Temperature Stiffness and Brittle Points in Elastomers," by F. L. Graves and A. R. Davis, *India Rubber World*, vol. 109, October, 1943, p. 41.

91 "Tubeless Tire Experiments Draw Considerable Attention," *Rubber Age*, vol. 52, December, 1942, p. 251.

92 "Tire Sandal," *India Rubber World*, vol. 107, November, 1942, p. 179.

93 "Carpet Pile" Retreading Material Developed by Alexander Smith Co.," *Rubber Age*, vol. 53, September, 1943, p. 539.

94 "The Morner Lifesaving Suit," *Rubber Age*, vol. 53, April, 1943, p. 37.

95 "Self-Sealing Fuel Tanks," *Rubber Age*, vol. 53, September, 1943, p. 545.

96 "New Type Airplane Tire," *Rubber Age*, vol. 52, March, 1943, p. 515.

97 "Nonskid Airplane Tire," *Rubber Age*, vol. 52, March, 1943, p. 523.

98 "New Channel Tread Tire," *Rubber Age*, vol. 54, October, 1943, p. 70.

99 "Camel Tread Sand Tires," *India Rubber World*, vol. 108, August, 1943, p. 494.

100 "Kok-Saghyz Tires," *India Rubber World*, vol. 108, August, 1943, p. 490.

101 "Schools for Rubber Tappers Being Set Up in Western Hemisphere," *Rubber Age*, vol. 54, October, 1943, p. 55.

102 "Cryptostegia Research in Haiti—I," by R. Symontowne, *India Rubber World*, vol. 108, May, 1943, p. 148.

103 "Cryptostegia Research in Haiti—II," by R. Symontowne, *India Rubber World*, vol. 108, June, 1943, p. 259.

104 "Latin-American Developments," *Rubber Age*, vol. 53, July, 1943, p. 344.

105 "Progress in Hemisphere Rubber Plantation Development," by E. W. Brandes, *India Rubber World*, vol. 108, May, 1943, p. 143.

106 "Expansion of Guayule Program Forecast by Rubber Officials," *Rubber Age*, vol. 53, September, 1943, p. 537.

107 "Rubber-Like Material From Jojoba Nut Reported by Glidden," *Rubber Age*, vol. 53, July, 1943, p. 344.

108 "Development of Rubber in Tropical America," by E. N. Bressman, *Rubber Age*, vol. 53, August, 1943, p. 427.

109 "The Production of Rubber in South and Central America," by B. V. Crane, *India Rubber World*, vol. 107, December, 1942, p. 259.

110 "Rubber After the War—I," by K. E. Knorr, *India Rubber World*, vol. 108, July, 1943, p. 356.

111 "Rubber After the War—II," by K. E. Knorr, *India Rubber World*, vol. 108, August, 1943, p. 464.

112 "Rubber After the War—III," by K. E. Knorr, *India Rubber World*, vol. 108, September, 1943, p. 556.

113 "Rubber After the War—IV," by K. E. Knorr, *India Rubber World*, vol. 109, October, 1943, p. 49.

114 "The Role of Soap in the Rubber Program," by G. Leffingwell and N. Radin, *Rubber Age*, vol. 52, December, 1942, p. 235.

115 "Surface-Active Agents," by F. J. Van Antwerpen, *Industrial and Engineering Chemistry*, vol. 35, January, 1943, p. 126.

116 "Pigment Dispersion With Surface-Active Agents," by E. K. Fischer and C. W. Jerome, *Industrial and Engineering Chemistry*, vol. 35, March, 1943, p. 336.

117 "Unsaturation of Butadiene and Related Polymers," by A. R. Kemp and H. Peters, *Industrial and Engineering Chemistry*, Analytical edition, vol. 15, July, 1943, p. 453.

118 "Determination of Butadiene," by J. F. Cuneo and R. L. Switzer, *Industrial and Engineering Chemistry*, Analytical edition, vol. 15, August, 1943, p. 508.

119 "Properties of Rubber Solutions and Gels," by M. L. Huggins, *Industrial and Engineering Chemistry*, vol. 35, February, 1943, p. 216.

120 "Molecular Weights of High Polymers," by M. L. Huggins, *Industrial and Engineering Chemistry*, vol. 35, September, 1943, p. 980.

121 "X-Ray Studies of Reactions Involving Accelerators," by G. L. Clark, R. L. Le Tourneau, and J. M. Ball, *Industrial and Engineering Chemistry*, vol. 35, February, 1943, p. 198.

122 "Synthetic Rubber—A Spectroscopic Method for Analysis of Control," by R. B. Barnes, U. Liddel, and V. Z. Williams, *Industrial and Engineering Chemistry*, Analytical edition, vol. 15, February, 1943, p. 83.

123 "Electron Microscopy in Chemistry," by V. Zworykin, *Industrial and Engineering Chemistry*, vol. 35, April, 1943, p. 450.

124 "Catalytic Alkylation of Benzene With Ethylene," by W. A. Pardee and B. F. Dodge, *Industrial and Engineering Chemistry*, vol. 35, March, 1943, p. 273.

125 "Butadiene by the Houdry Process," by C. H. Thayer, E. R. Lederer, and R. C. Laissiat, *Chemical and Metallurgical Engineering*, vol. 49, November, 1942, p. 116.

126 "Manufacture of Butadiene From Ethyl Alcohol," by J. A. Gamma and T. Inouye, *Chemical and Metallurgical Engineering*, vol. 49, December, 1942, p. 97.

127 "Wheat as a Raw Material for Alcohol Production," by W. H. Stark, P. Kolachov, and H. F. Wilkie, *Industrial and Engineering Chemistry*, vol. 35, February, 1943, p. 133.

128 "Alkylated Cresols From Refinery Gases," by W. Weinrich, *Industrial and Engineering Chemistry*, vol. 35, March, 1943, p. 264.

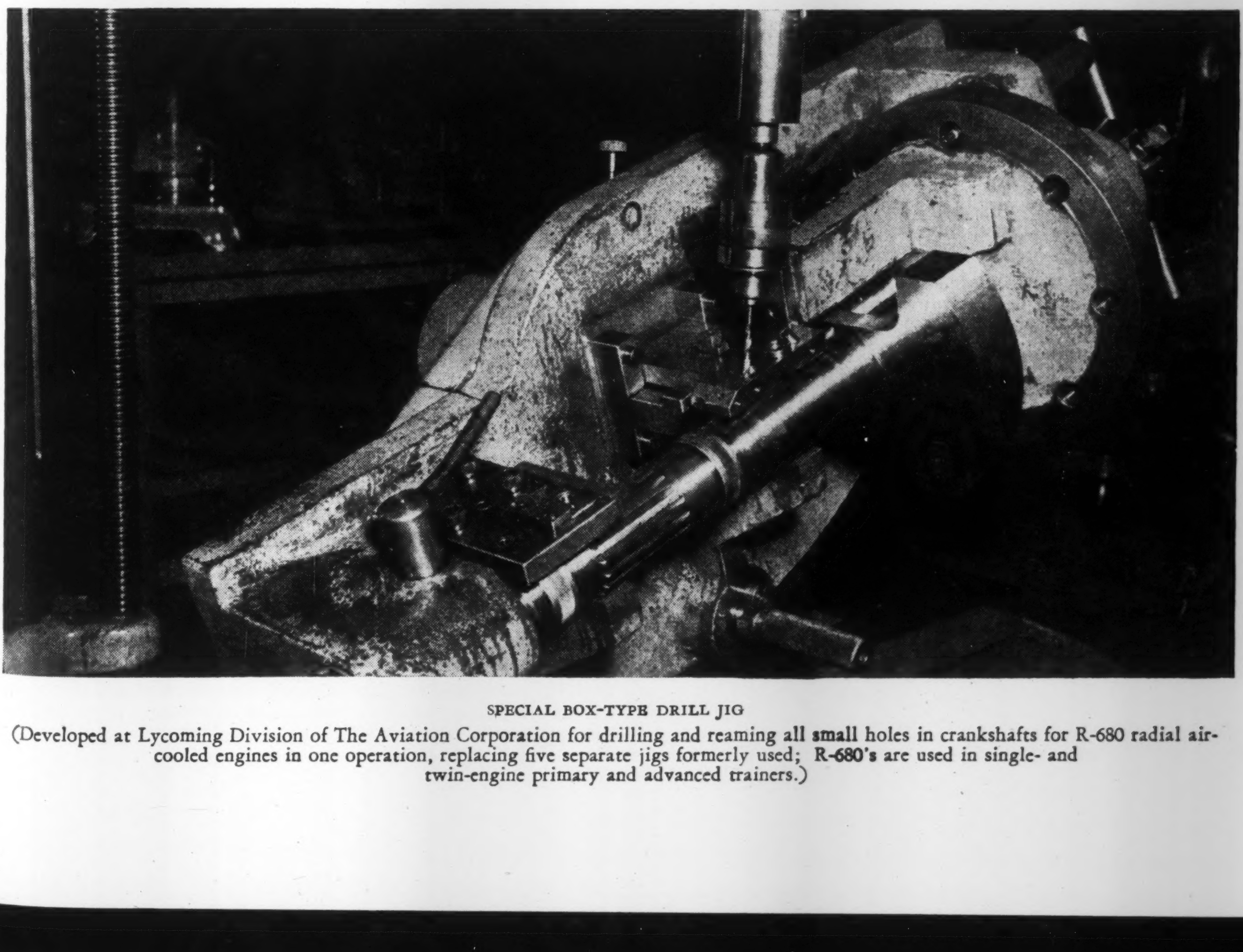
129 "Symposium on Industrial Reaction Rates," *Industrial and Engineering Chemistry*, vol. 35, May, 1943, pp. 504–575.

130 "Rayon-Cotton Tire Cord Controversy Flares Up Again in Official Circles," *Rubber Age*, vol. 53, August, 1943, p. 443.

131 "Progress Report No. 2 of the Rubber Director," by W. M. Jeffers, *India Rubber World*, vol. 107, March, 1943, p. 576.

132 "Progress Report No. 3 of the Rubber Director," by W. M. Jeffers, *India Rubber World*, vol. 108, June, 1943, p. 262.

133 "Charles Goodyear Memorial Lecture, The Second Mile," by L. B. Sebrell, *Industrial and Engineering Chemistry*, vol. 35, July, 1943, p. 736.



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FUTURE PROSPECTS *for* DIESEL-ENGINE FUELS

By ARCH L. FOSTER

REFINERY EDITOR, "OIL AND GAS JOURNAL," TULSA, OKLA.

FOR two decades, more or less, the petroleum supplies from which are obtained the fuels required by high-speed Diesel engines have also been in great demand as charge stock for gasoline-producing cracking processes. The distribution of these supplies has not always been determined wholly on the basis of economics, nor can it be while a war is in progress, but it appears likely that economics will become the determining factor in the future.

Today war demands must be supplied, including both the needs of the armed forces and the industrial army behind the gun-fighting front. Nonessential demands are being supplied as far as possible from surpluses left after the primary needs have been satisfied.

Speaking before the Society of Automotive Engineers in Cleveland, Ohio, last June a prominent and well-informed fuels-and-lubricants technologist stated, in part,[1] "After World War II. . . . . . the extremes between octanes for gasoline engines and cetanes for Diesel engines will broaden in favor of high octanes to the detriment of Diesel-fuel ignition quality." He later remarked, "At the rate at which the production of high-octane aviation fuel is going ahead at the expense of kerosene and distillates (the source of Diesel fuels), suitable Diesel fuels will be on the critical list by 1944." While we must agree with these general conclusions so far as the war period is concerned, we believe the postwar future of the Diesel engine is of great importance. Essential Diesel-engine operations are now being supplied with reasonably satisfactory fuels in reasonably satisfactory amounts, simply because it is necessary to the proper and successful prosecution of the war. Variations are due to the difficulties of transport, supply, and forecasting the requirements under wartime conditions. Barring the possibility of a totalitarian state, in one guise or another, in the postwar period in these United States, good economics, i.e., the law of supply and demand, may be expected to take over its normal function interrupted inevitably by the war.

The consumption of premium-quality distillates having the properties of kerosene and heavier fuels, from which Diesel fuels are drawn, will be determined over a period of time by comparative prices. Under normal conditions of private enterprise these premium-quality fuels are worth more as Diesel fuels, compared to fuels of lower ignition quality, than as furnace and other oils. Consequently, the Diesel operator will be able to purchase these fuels under favorable economic conditions. Fuels of lower Diesel-ignition qualities are, in most cases, quite as satisfactory as furnace oils, as are the high-cetane-number fuels, since detonation, preignition, and the like, are not important in heating-furnace operation. Therefore, in any contest for the better-quality distillate oils the application from which the greatest return may be obtained is the one which can afford to use these fuels at the highest price.

Generally speaking the best Diesel-engine fuels are among the best charge stocks for the thermal cracking unit for high-octane-number gasoline production. As present-day refineries are operated, these distillate fuels are suitable without any treating, or at worst with a minimum of inexpensive treatment, for immediate consumption as Diesel-engine fuels. The more paraffinic the virgin distillate is, the better its qualities for Diesel fuel. However, some highly paraffinic, high-cetane-number "gas oils" yield relatively low-octane-number motor fuels (gasoline) and become better charge stock for a recracking operation, particularly as to the octane number of the product, made by cracking the heavy oil a second time. Nevertheless much of our motor fuel has been and will be produced from paraffinic or mixed-base gas oils, from the necessity of available supply.

To obtain a partial view of the situation as to Diesel-fuel supply and the demands to be expected on the petroleum fractions from which Diesel fuels are drawn, we note from Bureau of Mines statistics available before censorship stopped their publication the production of distillate fuels and gasoline, Table 1.

TABLE 1

Date	Crude processed 1000s bbl	Dist. fuel oil 1000s bbl	Dist. fuel oil Per cent crude	Motor gasoline 1000s bbl	Motor gasoline Per cent crude
January, 1942	119,032	16,902	14.2	53,049	44.6
June, 1942	105,376	15,210	14.4	39,827	37.8
December, 1942	113,342	18,073	16.0	42,116	37.2

It is noteworthy that a small but gradual uptrend in distillate-fuel production accompanied a decided drop in motor-fuel production from 44.6 per cent to 37.2 per cent. These figures are not conclusive, since several effects of the war situation impinged on the production, and the data cannot be considered typical of normal operations. They do show, however, that the production of distillate fuels from which Diesel fuels are drawn at least did not decrease during that period.

Introductory to some calculations of the relative costs and returns from refining Diesel and spark-ignition fuels (gasoline), note these prognostications of the ignition rating of motor and Diesel fuels for the future.[1] House-brand (regular) gasolines will be 80 octane number, as compared to 70–75 before the war; premium grade (ethyl) fuels, 87–90 octane number; third grade, 72–75 octane number, equivalent to regular grade in 1941, tractor and distillate fuels, 50 octane or 40 cetane number. Assuming that these estimates are approximately correct, the refiner is faced with the problem of net returns from the conversion of his distillate fuels either to Diesel or motor fuels.

In forecasting the amounts of motor fuel and aviation fuel which may be made in comparison to that which have been made in the past, the total of these two fuels produced in December, 1942, has been estimated at somewhat less than 1,500,000 bbl per calendar day. With a drop of 20 per cent or more in motor fuel made, and with unknown but privately estimated aviation fuel increases, the total for 1943 is expected to be slightly larger than this over-all amount. Much of the increase in aviation fuel will derive from good-quality gas oils. Consequently, it is estimated that the total volatile fuel produced by the end of 1943 may require as much as 100,000 additional barrels of gas oil per day. Some 210,000,000 barrels of

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[1] "Octanes or Cetanes After World War II?" by C. M. Larson, S.A.E. Meeting, Cleveland, Ohio, June 2–3, 1943.

Contributed by the Oil and Gas Power Division and presented at the Annual Meeting, Nov. 29–Dec. 3, 1943, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Condensed.

distillate fuel oil were produced in 1942; assuming an equivalent potential production in 1943, the 36,500,000 barrels required for additional volatile fuel for this year—or production at this rate by the end of this year—still leaves about 175,000,000 barrels of distillate fuels for all purposes, not including the recycle oils obtained from cracking processes as by-products. In making these calculations we cannot feel greater confidence in the basic assumptions than that they can be accepted as of the general order of magnitude of the more recent figures which actually obtain. Censorship prevents any effort toward greater accuracy or exactness.

RELATIVE COSTS OF DIESEL AND MOTOR FUELS

Fortunately, as to qualities, specifications and property requirements, costs, and the like, for Diesel and motor fuels, more exact information is available. Assume, for the sake of indicative calculations, a refinery price for medium-grade Diesel fuel of four cents per gallon for, say, 35–40 cetane number. At the same time and place house-brand gasoline of 70–72 octane number sold for six cents per gallon, a margin of two cents in favor of gasoline. The refiner must pay for cracking costs, cracking losses, degradation of cracking-plant charge stock from this two cents and still break even, or else he will profit better by selling the distillate fuel—Diesel oil—at four cents without incurring the additional cracking costs.

Cracking losses vary widely, but, assuming a 15 per cent loss in cracking these potential Diesel fuels, 10 per cent of degraded (partly cracked) distillate fuel oil, and 75 per cent gasoline by thermal cracking, we find that the total gross return from a barrel (42 gallons) of the fuel oil (good either for cracking stock or Diesel fuel), is $1.68. Gasoline at the going price, 75 per cent of 42 gallons, yields $1.94; 4.2 gallons of heavy fuel oil—refractory recycle (partly cracked) stock, ten per cent yield at $1.50 per barrel—brings in $0.15, for a total of $2.09. Therefore, the additional return at these prices for the refiner to crack fuel oil to gasoline is $0.41 per barrel or about one cent per gallon. The refiner may make a small paper profit at this price differential.

Assume a tank-wagon price of 9.5 cents per gallon for house-brand gasoline, 8.1 cents per gallon for Diesel fuel in the run tanks. Total gross return for Diesel fuel at this price is $3.40 per barrel. With the same yield-loss for thermal cracking, the return from gasoline from a barrel of fuel oil is $3.34; a loss of about 0.2 cents per gallon as compared to selling the fuel oil as Diesel fuel. Assuming another actually reported set of typical tank-wagon prices for these two products, 7.2 cents for Diesel oil and 9.3 cents for gasoline, by the same calculations a barrel of distillate fuel oil will return $3.238 as gasoline, $3.030 as Diesel fuel. This gives gasoline an advantage of about 0.5 cent per gallon. Thus, the refiner can make a profit-making gasoline to the extreme yield in the first instance, can *possibly* break even on the third situation, and will profit best by selling the distillate oil as Diesel fuel in the second instance.

These data apply specifically to thermal cracking under conditions approximating those obtaining before World War II began. At that time 100-octane-number aviation fuels were used in relatively small amounts. Every indication is that this fuel will be in much greater demand: Much higher octane-number ratings will be required after the war than before. The quantity which will be required is a large "X" looming strong in the refiner's postwar equation. One good authority has estimated that within two years after the war, peacetime 100-octane-number aviation fuels will be in demand at five times the prewar rate for 91-octane-number fuels.

Fuels of these aviation-quality levels require catalytic cracking of heavier fractions to produce the properties which are so indispensable to aviation fuels. Motor fuels will require thermal cracking and doubtless in addition a considerable amount of catalytically cracked fuel to attain the 80 to 90-octane-number levels prophesied for postwar fuels. Thermally cracked fuels are not satisfactory for aviation purposes, consequently thermal cracking will be applied entirely to making motor fuels. Catalytically cracked gasolines may be used for both purposes. Yields of finished catalytically cracked gasoline range from about 40 per cent to about 55 per cent, with 40 per cent to 50 per cent recycle gas oil, that is, gas oil which has passed through the cracking unit at least once.

It is in this recycle oil that a ray of hope appears for the Diesel-fuel user; not for the production of large quantities of first-class, high-cetane-number Diesel fuel but for relatively large amounts of (for cracking) undesirable recycle gas oil which may be neither high nor low in cetane number but intermediate in this quality. Data on this point are by no means incontrovertible as yet, but a possibility exists which improves the outlook somewhat in comparison to thermally cracked recycle stocks.

Thermally cracked oils are highly olefinic in character, that is, chemically "short" on hydrogen, hard to crack again profitably but poor also as Diesel fuels. These cracked oils, however, can be used at reduced prices for furnace oils, household and industrial. They are often cracked to heavy fuel oils. In any case it now appears that medium-range catalytic recycle oils, while not premium Diesel fuels by any means, offer some advantages over thermally cracked oils for Diesel fuels. Catalytically cracked recycle stocks are less olefinic (more hydrogen) than those obtained from thermal cracking units and are more aromatic, according to some authorities who have had experience with both products. In this connection, it is possible that combination of such catalytically cracked recycle stocks with ignition-quality improver additives may offer possibilities for fair-to-good Diesel fuels if and when virgin paraffinic stocks reach premium price levels.

Another more definite and indicative fact is present in the catalytic cracking picture. Paraffinic-base oils are not the best charge stocks for catalytic cracker processes, if some published data are to be believed. A recent report[2] shows yields of 84-octane-number gasoline from paraffinic gas oils; 87.4 octane number from mixed-base gas oils, and 92.0 octane number from naphthenic gas oils. If other considerations—price, availability, market product demand, and the like—are equivalent, then it may be expected that mixed-base and naphthenic distillate fuels will be premium charge stocks; gasoline from such stocks may be increased to 99 and 96 octane number, respectively, with 4 cc of tetraethyl lead (ethyl fluid). The margin of advantage for the refiner, over the paraffin-derived catalytically cracked gasoline, may make a large difference, especially in aviation-fuel production and cost, and when octane-number increases well above 100 equivalent for such fuels are produced.

It is highly probable that recycle oils from catalytic cracking units in the refiner's future economy may show better than intermediate cetane-number ratings. Several years ago[3] it was reported that gas oils from recycle stock of the Houdry catalytic cracking process showed considerable improvement over thermally cracked oils of similar boiling range. Ratings of 46 cetane number were quoted for catalytic fuels as compared with 35 or lower for thermally cracked fuels of the Diesel type. More recent developments are cloaked in secrecy yet indicate that this advantage is probably quite as good as the indications quoted, perhaps appreciably better. For example, in Table 2 note the comparisons between straight-run Diesel fuels and similar boiling range, i.e., volatility range, fuels derived from the same stocks after they have been cracked to yield 45 per cent of motor fuel.

It is notable that the greatest degradation of cetane number occurs in those oils which are of the naphthenic type which have poor cetane ratings even in the straight-run product, and that in those Diesel fuels of highest ignition quality the degradation is least.

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[2] "Thermofor Catalytic Cracking Process," *Oil and Gas Journal*, Nov. 12, 1942, p. 96.

[3] "The Houdry Process and Its Relation to the Diesel Industry," by W. S. Mount and E. T. Scafe. Presented at A.S.M.E. National Oil and Gas Power Conference, June 19–20, 1940, Asbury Park, N. J.

TABLE 2 CETANE NUMBERS OF STRAIGHT-RUN AND CATALYTICALLY CRACKED DIESEL FUELS

Crude	Cetane numbers Catalytically cracked	Cetane numbers Straight-run
Pennsylvania	62	64
Oklahoma City	55	56
Healdton (Okla)	52	53
Illinois	48	56
Kansas	46	58
South Texas	40	54
Gulf Coast	30	37
Mirando (Texas)	24	28

Thus catalytic cracking may well tend to make high-cetane-number Diesel fuels more available than when all of our cracking capacity was thermal in type. The only direct relief from the disadvantages of olefinic, thermally cracked Diesel fuels with their low cetane numbers and deposit-forming tendencies is by hydrogenation of these products, a comparatively expensive and uneconomic operation under present conditions. Since higher octane numbers appear to be obtained in catalytically cracked motor and aviation fuels from naphthenic and mixed-base stocks than from paraffinic stocks, the trend will be inevitably toward freeing the paraffinic stocks (gas oils) for thermal cracking or for any other purpose. This trend may be accentuated as more and more of our cracking capacity is converted to catalytic processes, a situation which will follow gradually as a matter of course, it is believed.

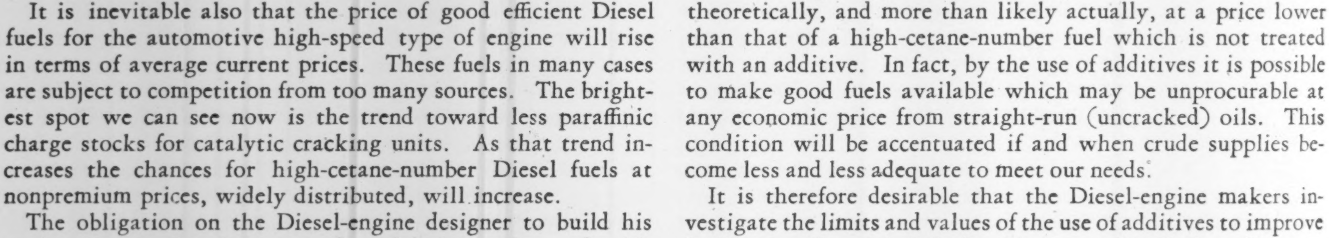
It is inevitable also that the price of good efficient Diesel fuels for the automotive high-speed type of engine will rise in terms of average current prices. These fuels in many cases are subject to competition from too many sources. The brightest spot we can see now is the trend toward less paraffinic charge stocks for catalytic cracking units. As that trend increases the chances for high-cetane-number Diesel fuels at nonpremium prices, widely distributed, will increase.

The obligation on the Diesel-engine designer to build his engine so that the cheaper grades of fuel may be used with advantage has not lessened. In fact that obligation has increased during this war and will so continue afterward. One of the two or three main advantages of the Diesel engine is economy of operation, of power generation, of fuel cost. If that advantage is lost by building for premimum-price fuels, it is doubtful if, in the users' minds, the mechanical efficiency gained by high-cetane fuels will offset the extra cost of these premium fuels. The previously mentioned authority says, "It is up to the Diesel-engine designer to utilize lower cetanes to the utmost to offset the vast lead the gasoline-engine designer, especially the aircraft engineer, has through 100-plus-octane fuels which will be available in greater quantities than the Diesel fuels after World War II." It is believed that, while utilizing every economic and technical advantage which offers, a Diesel-engine development program based on the aforementioned principles is the safest, surest route for success for Diesel-engine builders and their customers.

One avenue of escape from the dilemma of low cetane numbers which has not received the attention we believe it deserves from the Diesel-engine maker lies in the addition of chemicals for improvement of ignition quality. Twenty years ago the usefulness of tetraethyl lead in improving antidetonation properties of fuels for spark-ignition engines was discovered by Midgley and Boyd. The refining industry during the intervening time has used tremendous quantities of this product. Few motor fuels are made without it, only one major refining company producing its gasoline without the use of "lead." Although this knock improver has a few disadvantages under certain operating conditions, its advantages are so great and so obvious that refiners can foresee no time in the future when its use will be less economical than any other for "getting several octane numbers easily and cheaply."

So far as the author knows relatively small amounts of Diesel-fuel additives are used to improve ignition quality. The purpose of these additive materials is, technically speaking, practically the opposite of that of tetraethyl lead. Lead slows down the rate of combustion of a fuel-air mixture, preventing its reaching explosive violence and velocity. Diesel fuel must burn easily, quickly, with a minimum time lag. The degree of perfection reached in a Diesel fuel on this quality is measured now by cetane number. Additives which increase the "burnability" of Diesel fuels under Diesel-cylinder conditions may improve a poor fuel to the status of a fair or a good fuel, enabling the user to purchase a product which is available theoretically, and more than likely actually, at a price lower than that of a high-cetane-number fuel which is not treated with an additive. In fact, by the use of additives it is possible to make good fuels available which may be unprocurable at any economic price from straight-run (uncracked) oils. This condition will be accentuated if and when crude supplies become less and less adequate to meet our needs.

It is therefore desirable that the Diesel-engine makers investigate the limits and values of the use of additives to improve ignition quality of their fuels. Numerous chemical products are known and used to do this more or less effectively. Organic nitrites, such as amyl nitrite, some amines and complex organic nitrogen compounds, and, more recently, organic sulphur compounds have been tested and strong claims are made for their efficacy. The refining and spark-ignition engine industries have spent tens of millions of dollars to develop premium fuels, and additives are one of the important positive outcomes of that research. It seems high time that the refining and Diesel-engine industries carry out systematically more far-reaching and comprehensive research to determine means by which Diesel fuels may be improved and the Diesel cycle retain its inherent efficiency advantage.



LARGE CRANKSHAFT

(This crankshaft, cast of Meehanite metal by Cooper-Bessemer and shown in its rough-cast stage, is 7 ft, $8^{7}/_{16}$ in. long. It is obvious that finishing this shaft will involve neglible machining and waste metal compared to producing the same shaft by block forging.)

The FOREMAN *as a* PART *of* MANAGEMENT

By HARRY B. COEN

DIRECTOR OF LABOR RELATIONS, GENERAL MOTORS CORPORATION, DETROIT, MICH.

BASED on my own experience of more than 30 years in industry, as a mechanic, foreman, superintendent, and plant manager, I cannot conceive of the foreman's being anything else but a part of management, any more than we could speak of an arm except as an essential part of the body.

To infer otherwise indicates a lack of understanding of the foremen's work in the shop or a deliberate effort to confuse the issue.

For myself, I can say that the greatest promotion I have ever received since I left the railroad business in 1914 came when I was made a foreman in the assembly department of an automobile plant.

I can't recall now that anyone told me at that time that I was a part of management. I guess they didn't have to—I knew it.

Yet, today, from much of the discussion, newspaper stories, and debate going on, a person would imagine that a concrete wall ran down through all factories dividing the people who work there into three clean-cut groups: Those on one side who belong to the great mass of workers and do exactly what they are told to do; those at the other extreme who do nothing but tell the workers what to do and when to do it, with little regard for their welfare; and those in the middle—the foremen --who "catch hell" from both sides.

Anyone who has had any practical experience in industry knows any such idea is far from the truth.

First, to debunk some of the loose thinking of those people who seek to split the foreman away from the management organization, I want to make a blunt statement of fact: In General Motors plants the foremen are part of the management organization. They are ***not*** the "Forgotten Men." They are ***not*** a link between the management group and the employee group. They are ***not*** the "go-betweeners." As a matter of fact, they are not merely a *part* of management; they are the management at the ***grass-roots level***—the most important level in the factory organization.

Let us back out from among the trees and take a good look at the woods. Today the change brought about by the Wagner Act is ancient history; but the change it has brought about in the relationship between foremen and their men is not. To illustrate this, let me read the following from a booklet published by an international union entitled, "How to Win for the Union." The section is headed appropriately, "The Care and Feeding of Foremen."

> With the coming of the Union, the foreman finds his whole world turned upside down. His small-time dictatorship has been overthrown and he must be adjusted to a democratic system of shop government. Naturally many foremen resent this change and continue a hostile attitude towards the Union after higher company officials may have decided to work along with the Union.
>
> This makes the steward's problem difficult. He must convert the foreman to the democratic processes of collective bargaining and establish a sound working relationship with him as an individual.
>
> Many inexperienced committeemen and stewards feel that the way to do this is to get tough with their foremen. They feel that threats and fistbanging will do the job for them. In 1937 some union committeemen used these methods.

Experience has shown that this approach does not work forever.

With the coming of the union, the foreman *did* find his whole world changed and it required a considerable period of time for him to make the necessary adjustments and reconcile himself to this new order of things. Since the foreman is the first management representative with whom the union committeeman comes in contact in the ordinary grievance procedure, he has had to learn a new business. On the other hand, the union committeeman must learn how to conduct himself. This educational process is slow and requires a good deal of patient work.

This fundamental change in the relationship between the foreman and his men, in plants where unions have bargaining status, is further complicated. The manufacturing industry in this nation has been called upon to produce the greatest volume of war goods known in the history of mankind. The vital need for these goods required that every short cut be taken. The magnitude of the task brought with it many new problems for the management organization, particularly the foreman. Consider for a moment the change-over from peacetime to wartime products; the influx of inexperienced employees who had no previous factory training; longer hours; increased absenteeism; higher employee turnover; upgrading; women replacing men; priorities; material shortages; and the like. In addition there was a flood of restrictive orders emanating from the War Labor Board, War Manpower Commission, War Production Board, the Treasury Department, and Labor Department; all of which affected the foreman in his job. An experienced foreman had his hands full coping with the production requirement alone without having to worry about these other matters—but he had to carry the load and he did.

This brings me to another point which relatively few people seem to fully appreciate.

NUMBER OF FOREMEN GREATLY INCREASED BY WAR PRODUCTION DEMANDS

The demands for increased production, of course, required a tremendous expansion in the size of the factory organization in order to meet the schedules.

This called for a correlative increase in foremen. Nearly half of our General Motors foremen have been appointed during the past year and a half. These men came from the ranks of our factory group and many from the ranks of union members. The problem of training such a large number of foremen in their new responsibilities is a story in itself. Fortunately for us many of these new foremen had the "know-how" to do the job. They knew the mechanics of the job but they needed help on the "humanics" side of the job as leaders of men. Further there remained the important task of indoctrinating this new group of foremen with the management responsibilities of their new assignments.

Since production was paramount, and technical or mechanical ability was the primary requisite, the natural result was that many foremen had to be placed on the job before they were fully prepared for it, with management "backfilling" with the other training as rapidly as possible.

In ordinary times, when relatively few new foremen were being added to the management organization at any one time, such new foremen were given sufficient training in these man-

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Contributed by the Management Division and presented at the Annual Meeting, New York, N. Y., Nov. 29–Dec. 3, 1943, of The American Society of Mechanical Engineers. Condensed.

agement responsibilities prior to the time they assumed full and complete charge of their new jobs. The requirements of the war program have made this impossible in many cases.

After analyzing and appraising this combination of pressure factors, there is little mystery that many people should get a false impression of the present status of the foremen in the management organization. Nor is there much mystery about the fact that the opportunist might get the idea that now is the time to attempt to split the foreman away from the management organization and make him a part of the mass movement.

FOREMAN'S ROLE IN MANAGEMENT ORGANIZATION

Now as to the second phase, the foreman's role in the management organization.

The foreman is in business. He is assigned a certain amount of floor space upon which to operate his business. He is supplied with equipment, tools, materials, and men to produce a product. He is responsible for the operation. Regardless of how carefully plans have been made for his guidance, these plans never anticipate the conditions, emergencies, and problems which invariably arise. Regardless of the best engineering, prints and specifications do not always contain all of the information necessary to make the products. Regardless of the best tool designing, tools seldom work perfectly for the first time or keep working as they should. New conditions arise which have never been met before. Regardless of the best organized material control, materials are not always perfect and do not always come on schedule. Regardless of the most careful selection of workmen, they are all different from one another. They take instructions differently, they respond differently, so that no sets of rules, plans, or procedures can be applied to the group through any mechanical formula.

With all these variables to contend with, none of which can be foreseen and planned ahead, the shop foreman does manage to produce the products he was hired to produce, and his ability to manage under these circumstances is the biggest single factor in his personal success, in fact, the *only* factor.

If this isn't management in the truest sense of the word, and the only sense of the word, I would like to know what it is.

In March, 1943, representatives of General Motors were called to appear before the Committee on Military Affairs of the House of Representatives to testify as to whether or not the foreman was a part of management.

In brief, these representatives of General Motors pointed out to the Military Affairs Committee that "management has inescapable responsibilities which cannot be delegated to others; that these responsibilities of management as they apply to employees and the work in the shop are carried out in the first instance by the foreman; that the dual allegiance which will arise if foremen are unionized will imperil their ability to fulfill their responsibilities to maintain efficiency and discipline of the men under their direction; and that, finally, it is fundamental that a man cannot serve two masters and if there were foremen's unions, a foreman would be continually faced with the problem of whether a particular decision or action would be serving the objectives of the union or serving the objectives of the management. Any attempt on the part of any foreman to 'ride both horses' would add to his own confusion and render him ineffective."

HOW TO GET BETTER FOREMEN

I do not want to create the impression that we in General Motors feel that the relationship existing between our foremen and their employees or between them and their associates in management cannot be improved upon. We are constantly striving to improve these relationships in keeping with changing conditions.

This is the keynote of the third subject I would like to discuss with you briefly: A few of the important fundamentals which must be recognized if we want the foreman to believe that his choice to become a part of management presents greater opportunity to him individually than the acceptance of any will-o'-the-wisp scheme in which he trades his identity as an individual for so-called mass security.

1 Care should be exercised in the selection of employees who have demonstrated potentialities for foremen's jobs, and in their preforemanship training.

2 The new foreman should be given the proper training to equip him to handle his new job.

3 The foreman must be fully advised of the extent of his responsibilities and should have the proper amount of authority to administer them. He must handle the employees under his jurisdiction fairly and must have the necessary firmness to insist upon getting from each of them a fair day's work for a fair day's pay.

4 It is management's responsibility to be sure that the foreman understands the objectives, policies, and procedures of the company. To train him in these is not enough. The day-to-day and man-to-man contacts between the foreman and higher supervision must demonstrate to him that he is part of the management organization.

5 Higher management should give the foreman all possible support and encouragement.

6 If possible, foremen should be consulted before major changes in policy affecting their relations are made.

7 All members of supervision should be informed as soon as possible regarding changes in company policy and decisions affecting them.

8 In the pressure to get out production, top management should not lose sight of its responsibility of welding the newly appointed foreman into the management organization and also of making him continue to feel that he is part of the organization.

9 In dealing with any of the members of the management organization, we must see that they receive fair treatment as individuals and that their contribution to the objective of the organization is recognized.

A PERSONAL CREED

In developing the fourth and final phase of my discussion, I want to express my personal beliefs with respect to any drive to make the foreman a part of a mass movement.

I firmly believe in a competitive economy because to my way of thinking the success the United States has achieved and the high standard of living which its citizens enjoy is the result of a competitive economy. And as long as the products we sell are customer-dictated there can be no compromise with the philosophy of better things for less money, and in such an economy nothing short of each man's best will do.

I also believe that there should be added to the Four Freedoms we speak so much about, another freedom—the Freedom of Opportunity, or perhaps it should be called the Freedom of Individual Initiative.

If the foreman is willing to trade his faith in his ability to get ahead on the basis of his own individual initiative for the lulling influence or the creeping paralysis of mass security on a lower standard of living, he does not have the stuff that it takes. If any part of management has softened up to the point of a willingness to trade mass action for the Freedom of Opportunity which is inherent in a free economy, it is high time that we face the issue and purge management of all such parasitical influences that would tend to weaken and destroy that kind of economy.

I am grateful for the freedom our country provides anyone, regardless of the side of the track he was born on, to use the talents given him and to make the most of himself; and I personally feel that this, the greatest of all freedoms, is well worth fighting for. I am also grateful for the privilege of being a citizen in the great American democracy which makes room for,

(*Continued on page 256*)

UNION MEMBERSHIP *and* COLLECTIVE BARGAINING *by* FOREMEN

By ROBERT H. KEYS

PRESIDENT, FOREMAN'S ASSOCIATION OF AMERICA, DETROIT, MICH.

THE Foreman's Association of America was started in August, 1941, by four of us at the Ford Motor Company. Our original idea was to form a group in just our division of the company for the protection of our rights. All of us were working foremen who had no idea that our movement would spread all through the Ford plants. Foremen whom we did not know personally, and had not heard of, would hear of it in other departments and divisions of Ford and voluntarily request membership. We did not even have membership cards for a while. Before we realized what was going on, our original handful had increased to thousands. Today, more than 95 per cent of all Ford foremen are dues-paying members of our association. Then, even more astonishing to us, we began getting inquiries from foremen in other large Detroit corporations. After inquiries, came demands for charters; something we did not have at the time. Moreover, we had more than 5000 members before a single person was paid for his time and effort in handling the many details of membership activity. Finally, we were forced to go on a business basis when the membership became too heavy for spare-time volunteer handling. We did not have even one paid organizer until Jan. 1, 1943. Our organizers today are not of the so-called professional variety, but are foremen who resigned their jobs when offered organizing positions in our association as a reward for their efforts. On Jan. 1, 1943, we had 8 chapters in 32 different plants, and a total membership of 9000. Today, just 11 months later, we have 60 chapters in 125 different plants, large and small, and a total membership of 18,000.

Large numbers of new foremen are coming in each month despite the adverse rulings of the National Labor Relations Board and other setbacks which we have experienced. Why should 18,000 foremen, many holding responsible positions for years with the same employer, join our association? Certainly they did not do so because they enjoy paying dues. It is equally silly to assume that there was, or is, any coercion.

To put it bluntly, we foremen were driven to unionize by the shortsighted policies of our various managements; policies that gave no recognition to, or protection for, our basic rights. We are not a class apart. We are human beings who react, as expected, to either fair or unfair treatment just as any one else does. For several years we have been in a bad spot. We have had to stand helplessly on the side lines and watch the rank and file bargain for, and get, equitable pay rates, practical grievance procedure, full seniority rights, proper job classifications, and, most important of all, a sense of security. While the ordinary worker was gaining these precious adjustments and concessions, we foremen have been getting conversation, banquets, picnics, and promises. The only difference today is that we do not get the banquets and picnics. Some of us do not even get the promises any more. But all of us still get conversation instead of constructive action.

For many long years we tried to adjust individual grievances with management by individual effort or "one-man" bargaining. Each of us failed. Is it any wonder then that we turned to collective action to achieve a status comparable to those working for us?

Some have thoughtlessly asked, "If you don't agree with the policies of your particular management, why don't you resign and work elsewhere?" To this we reply, "You show us where we can go and get a square 'shake' and we will do it." The fact is that foremen have no protective standing in most industries today, and the result is that we have lost confidence in our ability to get it other than by the proved method of collective bargaining.

The same reasons that actuated the rank and file to unionize and bargain collectively apply to us foremen. No less an authority than Eric A. Johnson, president of the United States Chamber of Commerce, made the following statement at the annual meeting of that body in 1943. Said Mr. Johnson, "The capitalism of complete laissez-faire, which thrived on low wages and maximum profits for minimum turnover, and which rejected collective bargaining and fought against justified public regulation of the competitive process, is a thing of the past."

Would it surprise you to learn that thousands of our members are actually getting less money than the workers they supervise?

I could cite one case after another to prove the point. Here is, for instance, a recent bit of trouble that our members went through at the plant of The Republic Steel Corporation in Cleveland.

First let me make it clear that while wages of the rank and file in many plants have risen as high as 80 per cent, the maximum raise for any foremen during the same period has been 20 per cent. Republic Steel foremen are paid a daily salary, supplemented by a peculiar overtime pay arrangement. As a result, there are several instances where a foremen has been paid $113 for ten-days' work, while a workman in his department has drawn from $200 to $266 for the same ten-day period. Does that explain why Republic Steel foremen joined the Foreman's Association of America? And yet that inequality of pay is only one of many grievances. This company is reported to have hired a man who knew nothing about rolling, cutting, or regular steel-mill work and paid him the same rate as a foreman. Naturally, the foremen did not like it and could not understand it. When the foremen's committee protested to the management no satisfaction was forthcoming. After that disregard of their rights, the foremen struck in a group. The result was a two-day work stoppage on October 8 and 9 which cost the war effort thousands of tons of steel.

Now the foremen at Republic Steel do not have to take their hats off to anybody when it comes to supporting the war effort. They too have sons and fathers and relatives in the armed forces. They too buy bonds to the limit and do everything they can, in every way they can, to help win the war in the shortest

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Contributed by the Management Division and presented at the Annual Meeting, New York, N. Y., Nov. 29-Dec. 3, 1943, of The American Society of Mechanical Engineers. Slightly abridged.

possible time. But, they too are human beings, and when they were treated like that their own self-respect forced them to walk out. In all fairness, ask yourselves what you would have done under similar circumstances.

The Republic Steel case is not an isolated or rare instance. In one way or other the same kind of treatment has been accorded foremen in other plants. Consider, please, the fact that foremen were chosen to supervise others because they had proved the hard way that they possessed the essential qualifications for leadership and responsibility. How can anyone say that such a group of keymen are not justified in unionizing?

In May, 1943, the National Labor Relations Board, by a vote of two to one, ruled that supervisory employees do not constitute appropriate units for collective bargaining. That decision still stands, but it has not killed our association and will not because we still have our grievances since that unconstitutional ruling. It is a decision that can be reversed, and even if it is not, there are other boards and procedure, provided by law, which will enable us to secure our reasonable demand for collective bargaining and security.

The adverse N.L.R.B. decision was given in the matter of the Maryland Drydock Company. It is entirely too long a ruling for me to quote, but of the three members, it is significant that the man who voted the minority opinion in our favor is the chairman of the N.L.R.B., Harry A. Millis. I will, however, quote some interesting conclusions which Mr. Millis wrote in his dissenting opinion. He said,

> The employers' case against foremen's organization and collective bargaining, in addition to the *fallacious claim* that supervisors are management and not employees, repeats many of the arguments formerly used by antiunion employers against the organization of rank and file employees in these same industries . . . . . in reaching its conclusions, the majority fails to give proper weight to the distinction between the two essentially different aspects of the position of foremen. On the one hand, they are agents of management, carrying out, although not formulating, management policies in the plant, mine, or shipyard. As such they act for management as the first step in the handling of grievances of rank and file employees, but they do not, in most cases, make decisions on grievances except in minor matters. They have no active part in the collective-bargaining conferences between management and the union of rank and file. In fact, one of their grievances is the lack of provision for conferences between management, foremen, and men on problems affecting all three groups. On the other hand, they are employees, in groups running into hundreds and even thousands in the great war industries, with serious problems of their own, as employees, in their relations to the management. It is these problems, ***not whims***, which have led to the current movement by these men for self-organization and collective bargaining. Parallel movements are found elsewhere as in Great Britain for example.

Mr. Millis states our position quite clearly. I only wish that time would permit quoting his whole minority opinion, but I do want to quote a couple of additional and quite important points which he made. "I believe," he said, "that there is a solution to the delicate problem of maintaining necessary and proper authoritative relations between supervisory and subordinate employees, without sacrificing the right of either group to bargain collectively under the act."

Mr. Millis was not advancing some new theory, but was basing his conclusions on history, for he said further:

> Organization and collective bargaining by supervisory personnel have long been accepted in the maritime and railroad industries, in the former for more than 40 years. Although it is common knowledge that the licensed personnel aboard ship exercise substantially more powers as representatives of management than the ordinary foremen in mass-production industries, I find no discussion in labor-relations literature to indicate that serious issues have arisen from their recognition for collective-bargaining purposes. With respect to the railroad industry, there are purely supervisory unions and unions which represent supervisors and their subordinates but in separate bargaining units. The National Mediation Board has recognized the right of these employees to representation; their organization has raised no unusual problems . . . . Why is not the experience in these fields persuasive that a parallel development, within the framework of the act, is feasible in the mass-production industries?

A part of Mr. Millis' final sum-up reads as follows:

> I conclude that supervisors in mass production are a group of employees whose right to organize and bargain collectively under the protection of the act should no more be denied than that of any other group of employees . . . . in a democratic society good industrial relations and efficient production must depend upon well-informed, self-respective, and mutually co-operative relationships between the three groups directly involved in production—management, supervisory employees, and rank and file workers.

Many arguments, most of them very farfetched, have been advanced by management as to why foremen should be prohibited from unionizing. At hearings on the Smith Bill in Washington before the House Military Affairs Committee in the spring of 1943, I heard some arguments voiced by executives that were indicative of the kind of thinking that has made an outstanding "fall guy" of the average foreman during the past several years. One of these statements was, "You can't serve two masters." Using that statement with reference to unionization of foremen is a reprehensible attempt to make mincemeat out of the Holy Bible.

The Foreman's Association of America is here to stay, because its very foundation rests upon the fundamental principles of justice and fair play. That is why we have been able to withstand the many severe tests to which our organization has been subjected since its founding. We claim that under the wording of the Wagner Act we foremen cannot, and will not, be deprived of our constitutional right.

We, too, believe in free enterprise, and no one has yet been able logically to prove that a foreman cannot function efficiently and loyally under the ideal system of free enterprise while a member of a union of his own choice. Beautifully worded empty theories, with no basis in fact, but which pretend to show that a foreman is a fellow who is a part of management without rights, are no substitute for a fair wage in proportion to ability, and for fair treatment regardless of ability. To listen to some people you would imagine that just because a foreman is a member of our association he has given up all ambition and individual initiative. Nothing could be further from the truth. It stands to reason that a supervisor who possesses outstanding ability can only develop and prove his capacity provided he is convinced that he is not being taken advantage of.

On Sept. 28, 29, and 30, 1943, the American Management Association held its annual convention at the Hotel Pennsylvania, New York City. The membership is largely composed of personnel directors.

One of their members, who spoke at the convention, is Guy B. Arthur, industrial-relations manager of the American Thread Company. He delivered an address on the subject of foremen, based upon a survey which he had recently made among a large number of supervisors in such diversified industries as steel, glass, food products, textiles, heavy machinery, hardware, paper, and wood products. The results show:

1 Fifty per cent who answered said they are definitely unhappy in their present work, and when asked why, 90 per cent of them blamed management.

2 Despite all that has been written and said about organization charts, 54 per cent stated they have no definite lines of authority; 70 per cent can count more than one boss. Regarding organization charts, many admit their company has a chart, but said, "It isn't followed out where the work is done," or, "Too many exceptions to that chart have been made during the recent expansion."

How any supervisor can perform his job without a definite line of authority has never been explained, but some managements still expect them to do so.

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DOES AN ENGINEER NEED HIS PROFESSION?

By W. E. WICKENDEN

PRESIDENT, CASE SCHOOL OF APPLIED SCIENCE, CLEVELAND, OHIO. MEMBER A.S.M.E.

[Addressing the annual dinner, Hamilton, Ontario, Feb. 7, 1941, of The Engineering Institute of Canada, William E. Wickenden, member A.S.M.E., and president, Case School of Applied Science, chose for his theme, "The Second Mile." Liberal extracts from the address were published in MECHANICAL ENGINEERING, April, 1941, pages 297–299, under the title "What Is a Profession?" The complete address was issued in pamphlet form by the Engineers' Council for Professional Development, and approximately 21,000 copies of this reprint have been distributed.

At the request of E.C.P.D. President Wickenden has rewritten the address for current use under the title "The Second Mile—A Resurvey, 1944." In the revision a concluding section, "Does an Engineer Need His Profession?" which is presented to readers for the first time, was added and is published here. A notice of the new E.C.P.D. pamphlet will be found on page 282 of this issue.—Editor.]

THE engineer needs his profession for his personal advancement. That is the purpose which brought it into being.[1] He needs it most at the beginning of his career. Perhaps you have heard the wisecrack on the bringing up of the American boy, "When my father and my mother forsake me, then the Boy Scouts will take me up." Just substitute *alma mater* and *professional society* in the right places. Young men need for their advancement wider sources of information, more varied personal associations, broader stimulation to achievement, and less formal contacts with their seniors than they usually find in their daily jobs. They also need earlier outlets for their organizing and executive abilities—something on a pilot-plant scale like the campus activities of college life. They can gain much from outside recognition. As men mature they come to value professional rewards—friendships, recognition, responsibility, pride in belonging, evidences of distinction, etc.—no less and often more than money rewards. These are the durable satisfactions of life.

The engineer, in a society based largely on group relations, needs his profession to safeguard his occupational and economic welfare. He needs protection against unethical competition, against indiscriminate use of the title "engineer," and against all influences which might undermine public confidence in his integrity and competence. He needs protection against those who assume that he is "just another employee" and against subprofessional groups seeking to act for engineers in the process. He needs protection against the leveling influences of unionism and of civil service. He needs the benefits of prestige built up through group publicity. He needs a collective instrument for shaping public policy in the realm of his responsibility. It is true that a professional organization is primarily a moral agency and not in itself an economic or political pressure group, but in the long run moral agencies are the more powerful and enduring.

The engineer needs his profession because of his stake in the advancement of knowledge and technical skill. Who has a larger stake, and who stands to gain more through pooling of effort? The ancients washed occasional nuggets of useful knowledge out of the gravel of common experience by individual placer mining, but science began to get on only when men organized agencies to collect, preserve, and disseminate knowledge and to mine the hidden veins systematically. Otherwise there would be no profession of engineering. Industrial research, invention, and the patent system, with all their incalculable benefits, tend to canalize knowledge and know-how in restricted channels. The general interest and professional advancement alike require that the reservoir of free knowledge, stored by centuries of untrammeled research, be constantly renewed. Few engineers can do much about it alone. Collectively their capacity to advance knowledge is beyond calculation.

Most of all that has been set down above has an idealistic base. If one insists on being a Philistine, it can easily be brushed aside with a "So what?" Some consider this the natural reaction of a man who day by day must give hard-headed answers to the questions "Will it work?" and "Will it pay?" and whose work leaves no room for wishful thinking. But look for a moment under the surface. By common consent, the quality most universal and indispensable among engineers is integrity; this is essentially something moral or idealistic. Ranking almost equal with integrity is devotion to duty; given a job, an engineer will see it through, come hell or high water; and so on through the whole catalogue of the engineer's distinctive virtues. Why is he so? Because a boss or a time clock is policing his efforts? Or a money incentive drives him? Or hoped-for applause urges him on? Well, hardly! Because he has had a soldier-like training and indoctrination? In some small measure. Because he has a tradition to uphold? Yes, no doubt. Or is it because of something within himself to which he dare not be disloyal, and a faith between himself and his colleagues—unspoken perhaps—which he dare not betray?

In matters of social concern is the engineer just a materialist, promising to save civilization by flooding it with gadgets? No more than other men who bear high responsibilities in the industrial order. He is not only an engineer but a citizen, not only an individual but one of a corporate group with a major contribution to make to the common good. Naturally, he has a concern that the prevailing social attitudes and public policies shall favor rather than hinder that contribution. Amid the present Babel of economic confusion he has a message to proclaim in clear and ringing terms—that our economic ills cannot be solved by division until they are first solved by multiplication, that the creation of wealth in a democracy is the job of free enterprise, and that the public has a far greater stake in stimulating technical progress than in policing prices and profits. The dimensions of this issue are no longer national, they are world-wide. Shall the engineer raise his voice from an individualistic soapbox, or through the amplifier of professional organization?

Professional idealism, both individual and social, is like religion. It does not thrive in isolation. It needs a culture medium, a church, or organization. The engineer's daily round

(*Continued on page 270*)

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[1] The first professional society, The Institution of Civil Engineers, was organized in London. The official account of its founding begins, "It was toward the end of the year 1817 that a few gentlemen, then beginning life, impressed by what they themselves felt were the difficulties young men had to contend with in gaining knowledge requisite for the diversified practice of engineering, resolved to form themselves into a society."

HEAT-TRANSFER DATA[1]

A New Correlation of Results of Huge's and Pierson's Tests on Convection Heat Transfer

By ERIC F. LYPE

RESEARCH ENGINEER, DE LAVAL STEAM TURBINE COMPANY, TRENTON, N. J.

IN 1937, O. L. Pierson and E. C. Huge[2,3] presented results of tests on convection heat transfer in crossflow of gases over tube banks. A correlation of these data was also given by E. D. Grimison.[4]

In order to facilitate the application of these investigations to the calculation of heating surfaces in steam boilers, the author has prepared two charts from which the value of the coefficient of heat transfer from gas to tube wall can be obtained for either staggered or in-line tube arrangements, and for any given value of tube spacing, tube diameter, gas velocity, and mean film temperature.

The relation between the various quantities is, as usual, expressed by the dimensionless Nusselt and Reynolds numbers

$$Nu = \frac{hD}{k} \qquad Re = \frac{GD}{\mu}$$

where

h = heat-transfer coefficient, Btu/(hr)(sq ft)(deg F)
D = tube diameter, ft
G = mass flow of gas, lb/(hr)(sq ft)
k = heat conductivity of gas, Btu/(hr)(ft)(deg F)
μ = dynamic viscosity of gas, lb/(hr)(ft)

The "mass flow" is defined by the relation

Mass flow = velocity of gas × specific weight of gas

There is no way to calculate the viscosity and conductivity of a gas mixture consisting of so many components as obtained by the combustion of fuels. However, the values of these two properties of the components are not very different from the respective values for air of the same temperature. Therefore the viscosity and conductivity of air have been used instead. These properties were evaluated at the mean film temperature

$$t = t_s + {}^1/_2(t_g - t_s)_m$$

where

t_s = average temperature of tube surface
t_g = gas temperature
$(t_g - t_s)_m$ = average temperature difference between gas and surface

For crossflow, the following can be written with sufficient accuracy

$$t_s = {}^1/_2(t_1 + t_2)$$

$$(t_g - t_s)_m = \frac{(t' - t_s) + (t'' - t_s)}{2}$$

where t_1 and t_2 are the temperatures of tube surface at both ends of bank; t' and t'' are the temperatures of gas at inlet and outlet. Then the mean film temperature is found as

$$t = {}^1/_4(t_1 + t_2 + t' + t'')$$

The experimental data can be represented by the empirical equation

$$\frac{Nu}{Nu_0} = \left(\frac{Re}{Re_0}\right)^n \qquad [1]$$

where Nu_0 and n depend upon the tube arrangement, and Re_0 = 40,000. However, the following simplifications are possible:

For staggered tubes: Nu_0 alone depends upon the arrangement
n has average value $^4/_7$
For tubes in line: n alone depends upon the arrangement
Nu_0 has average value 174

Thus the following relations are obtained from Equation [1]

$$\text{Staggered tubes: } Nu = Nu_0\left(\frac{Re}{40{,}000}\right)^{4/7} \qquad [2]$$

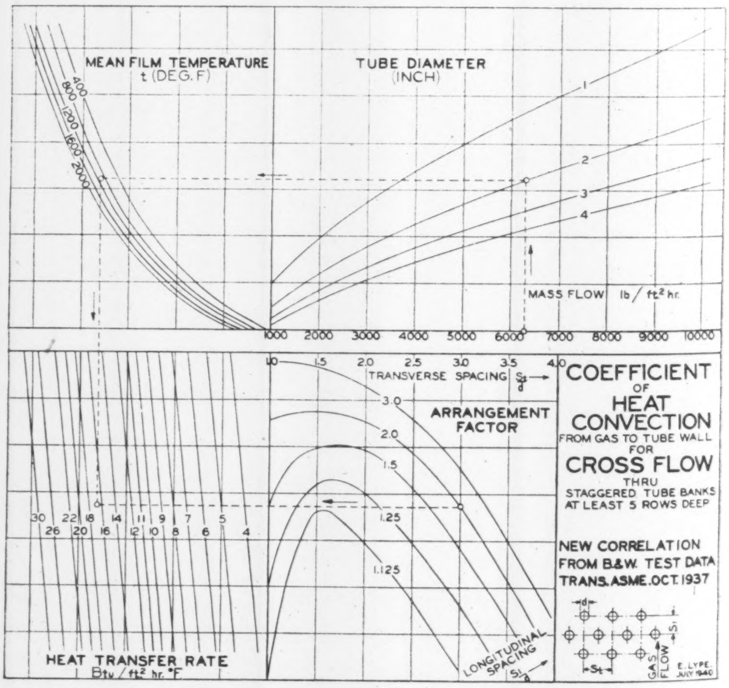

FIG. 1 COEFFICIENT OF HEAT CONVECTION FROM GAS TO TUBE WALL FOR CROSSFLOW THROUGH STAGGERED TUBE BANKS AT LEAST 5 ROWS DEEP
(New correlation from B.&W. test data.[2,3,4])

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[1] The correlation described in this article was prepared during the author's connection with Combustion Engineering Company, Inc., New York, N. Y.

[2] "Experimental Investigation of Influence of Tube Arrangement on Convection Heat Transfer and Flow Resistance in Crossflow of Gases Over Tube Banks," by O. L. Pierson, Trans. A.S.M.E., vol. 59, 1937, pp. 563–572.

[3] "Experimental Investigation of Effects of Equipment Size on Convection Heat Transfer and Flow Resistance in Crossflow of Gases Over Tube Banks," by E. C. Huge, Trans. A.S.M.E., vol. 59, 1937, pp. 573–580.

[4] "Correlation and Utilization of New Data on Flow Resistance and Heat Transfer for Crossflow of Gases Over Tube Banks," by E. D. Grimison, Trans. A.S.M.E., vol. 59, 1937, pp. 583–594.

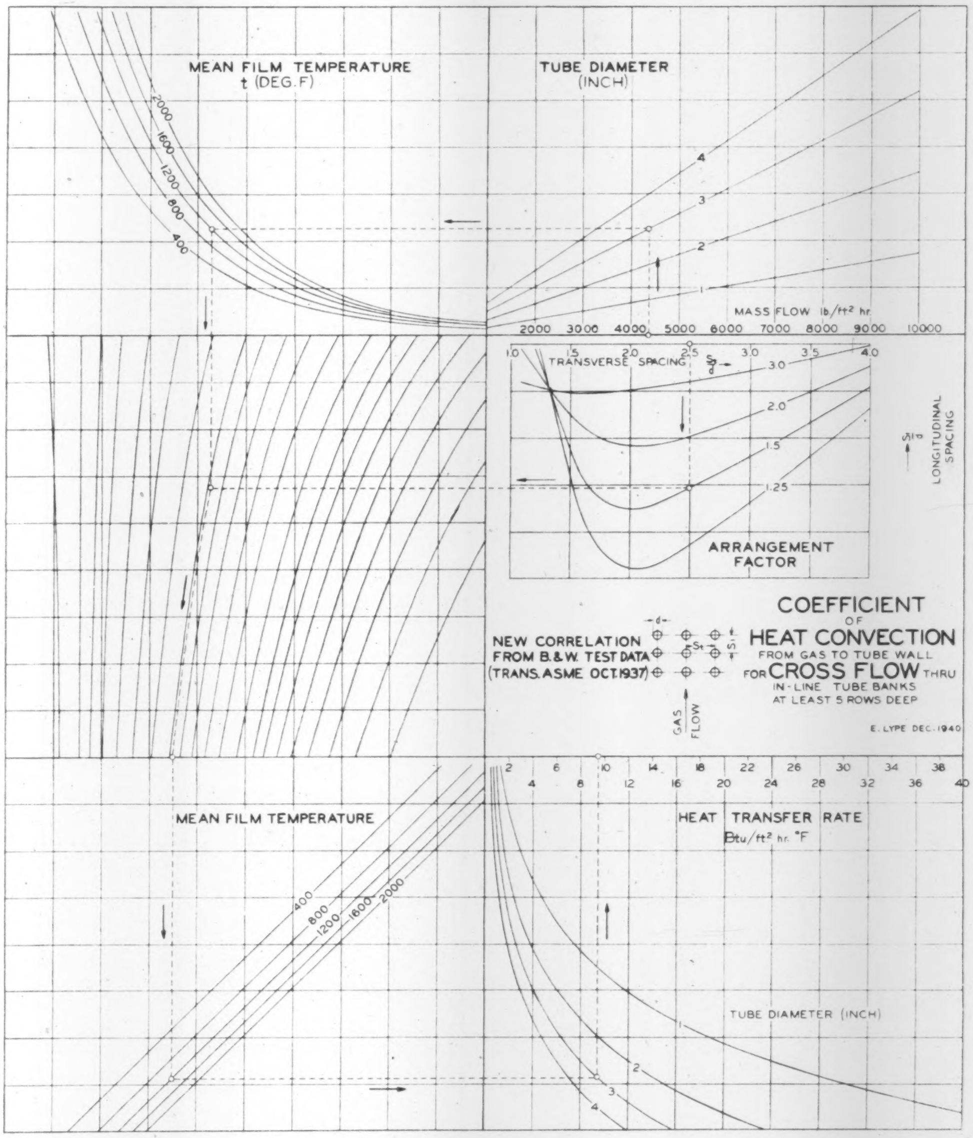

FIG. 2 COEFFICIENT THROUGH IN-LINE TUBE BANKS AT LEAST 5 ROWS DEEP
(New correlation from B.&W. test data.[2,3,4])

$$\text{Tubes in line:}\quad Nu = 174\left(\frac{Re}{40{,}000}\right)^n \ldots\ldots\ldots\ldots\ldots\ldots\ldots[3]$$

The simplifications made represent the empirical data with satisfactory accuracy. It must be kept in mind that it is of no avail to strive for extreme accuracy in the heat-transfer coefficient, since a considerable error is introduced into most calculations by the uncertainty as to what the effective heating surface is, particularly when the direction of gas flow changes.

The two "arrangement factors" are functions of the tube spacing.

If s_t = distance between tube centers normal to direction of gas flow

s_l = distance between tube centers parallel to direction of gas flow

then the tube spacing is the ratio of tube distance divided by tube diameter d, in. This gives for the arrangement factors

$$Nu_o = f_1\left(\frac{s_t}{d}, \frac{s_l}{d}\right) \qquad \text{and} \qquad n = f_2\left(\frac{s_t}{d}, \frac{s_l}{d}\right)$$

If these two functions are plotted against s_t/d with the parameter s_l/d, curves of a very sharp curvature are obtained. The same holds even for log Nu_0 and log n. Therefore the available test data do not afford an unambiguous interpolation for all spacings. The interpolation of the arrangement factors as it appears on the two charts, Figs. 1 and 2, is a compromise between consistency and the closest possible agreement with the experimental data.

In the calculation of the constants, the value of Nusselt numbers at a Reynolds number of 30,000 has been taken as the exact value. A reduction by 0.04 of the exponent n has been applied to Pierson's correlation of Nusselt versus Reynolds numbers, following Grimison's recommendation.

The number of tube rows in a tube bank has only a slight effect on the heat-transfer factor, as long as the bank is at least five rows deep. It is therefore within the limits of ordinary engineering accuracy to use the charts for all banks of not less than five rows in the direction of gas flow.

The two charts are the graphical representation of Equations [2] and [3], solved for the heat-transfer rate, h. The accuracy satisfies ordinary engineering requirements. The use of the charts may be illustrated by the following two examples:

Example 1: Convection Heat Transfer to Staggered Tube Banks. The following data are given:

G = 6300 lb/(hr)(sq ft), $d = 2$ in., $s_t/d = 3$, $s_l/d = 2$, $t_1 = t_2 = 700$ F, $t' = 1600$ F, $t'' = 1000$ F

The mean film temperature is found as $t = 1000$ F.

If Equation [2] is solved for h, it is obtained

$$h = G^{4/7}D^{-3/7}\left(\frac{k}{\mu}\right)^{4/7}\frac{Nu_0}{40{,}000^{4/7}}$$

This function is constructed in the chart, Fig. 1. The path begins in the upper right section at abscissa $G = 6300$, goes first to the intersection with the curve $d = 2$, and then to the ordinate, $G^{4/7}D^{-3/7}$. This ordinate becomes abscissa for the upper left section. The path continues to the intersection with the curve $t = 1000$ and then goes straight down to the ordinate of this section, $\log\left[G^{4/7}D^{-3/7}\left(\frac{k}{\mu}\right)^{4/7}\right]$. From there, the path continues straight into the lower left section to the intersection with another branch of the path which crosses into this section from the right and represents the arrangement factor. The latter is taken from the lower right section; from the abscissa $s_t/d = 3$ the path goes straight down to the intersection with the curve $s_l/d = 2$, and then horizontally toward the ordinate, $\log(Nu_0 \times 40{,}000^{-4/7})$. The sum of both co-ordinates of the lower left section is now log h. The straight lines in this section represent the lines $h =$ const, and the desired value of h is that line on which both branches of the path intersect. This occurs between $h = 16$ and $h = 17$, and by interpolation is obtained $h = 16.8$ Btu/(hr)(sq ft)(deg F).

Example 2: Convection Heat Transfer to Tube Banks in Line. The following data are given:

$G = 4400$ lb/(hr)(sq ft), $d = 3$ in., $s_l/d = 2.5$, $s_l/d = 1.5$, $t_1 = 850$ F, $t_2 = 750$ F, $t' = 1800$ F, $t'' = 1400$ F

The mean film temperature is found as $t = 1200$ F.

If Equation [3] is solved for h, it is obtained

$$h = \left(G \frac{D}{40{,}000} \mu\right)^n k \frac{174}{D}$$

This function is constructed in the chart, Fig. 2. The path begins in the upper right section at $G = 4400$, goes to the intersection with the curve $d = 3$, and from there to the ordinate, $G \frac{D}{40{,}000}$. This ordinate becomes the abscissa for the left section. The path continues to the intersection with the curve $t = 1200$ and goes straight down to the ordinate of this section, $\log\left(G \frac{D}{40{,}000} \mu\right)$. The path continues straight into the left center section to the intersection with another branch of the path which crosses into this section from the right and represents the arrangement factor. The latter is taken from the right center section: from the abscissa $s_l/d = 2.5$ the path goes straight down to the intersection with the curve $s_l/d = 1.5$ and then horizontally toward the ordinate n and farther to the intersection with the previously traced branch of the path. From here, the path runs parallel to the curves in the left center section to the next co-ordinate axis, $n \log\left(G \frac{D}{40{,}000} \mu\right)$ which is also abscissa for the lower left section. The path continues straight down to the intersection with the line $t = 1200$ and goes horizontally to the ordinate, $\log\left[k\left(G \frac{D}{40{,}000}\mu\right)^n\right]$. This ordinate is also abscissa for the lower right section, into which the path crosses horizontally to the intersection with another curve $d = 3$. From there, the path goes vertically to the last co-ordinate axis, which represents the heat-transfer coefficient h. It is found that, for this example, $h = 9.5$ Btu/(hr)(sq ft)(deg F).

Union Membership and Collective Bargaining by Foremen

(*Continued from page 252*)

3 Fifty-four per cent said their activities were restricted to a degree which handicaps their efforts.

4 The older foremen recognize the ability of time-study specialists, but do not think the question of wages of employees should be handled by others. In addition, they believed that they themselves should be trained to handle grievances, discharges, transfers, and the like. Two of those reporting said the worst restrictive force with which they dealt was their personnel departments.

5 Seventy-two per cent did not believe they have been or are being properly trained for the jobs they should do. They would like more information and training on individual differences, behaviorism, and personalities.

6 They want to understand thoroughly all of their company's basic policies and believe they could be helpful in revising existing policies and establishing new ones. They would like especially to be consulted on the formulation of all policies which affect their employees, since they are closer to these persons than anyone else in the organization. They feel that much employee dissatisfaction could be eliminated if such procedures were adopted.

7 Many mentioned the restrictions or limitations caused by having their responsibility for doing a particular job nullified by lack of corresponding authority. In many cases, they do not have a clear picture of how far they may go in exercising authority.

8 Many criticized the ridiculous training programs which management has purchased or developed for them—programs including everything from purchasing to selling.

9 They desire all management interpretations of each union contract, so that they can educate their people as to what it means and how it works. If a grievance or complaint concerning any of their people is being discussed by a superior, the personnel department, or any step of the grievance procedure, they want to be present, to hear what is said, to air their views, and have firsthand information regarding the disposition of the grievance.

10 Sixty-three per cent reported that they are not being paid proportionately higher wages than their subordinates. In fact, a surprisingly large number pointed out specific cases where individuals working under them are making more than they receive.

11 The personal objectives of the foremen in the survey were:

(*a*) Advancement
(*b*) Financial gain
(*c*) Security
(*d*) Help other people.

12 The foremen indicated that they have lost confidence in their respective managements.

Mr. Arthur then went on to say that if management wants foremen to *act* like part of management, then they should be treated accordingly. A good differential must be maintained between their earnings and those of nonsupervisory employees.

Mr. Arthur also stated that the *only* way that management can regain the confidence of the foremen, something that has been lost during recent years, is to give proper recognition to foremen and accept them into the ranks of management.

There you have the factual results of an honest survey made by a personnel director among many foremen in several different industries. Does it not prove our case conclusively? Please remember that the survey was made by one of the executives of top management, not by our association or any group of foremen.

The Foreman as a Part of Management

(*Continued from page 250*)

and gladly welcomes, those who will do a little more and a little better than they are paid to do, who take an interest in what they are doing, seek ways of doing better, and are willing to undertake greater and greater responsibility and greater and greater risks.

I can't get it out of my mind that the vast majority of Americans feel the same way I do about these liberties. Americans at heart are individualists who want to stand on their own two feet, make their own way, and get what is coming to them. America has been built by people like this which has resulted in the best land—by any measure—in all the world. We certainly want to keep it this way. This calls for all of us to keep our heads and to be able to clearly distinguish and to make the right choice between the silver-tongued promises of total security for all, and the freedom of opportunity for the individual.

Cost of Rendering CONSULTING ENGINEERING SERVICES

By M. X. WILBERDING

PRESIDENT, WILBERDING COMPANY, WASHINGTON, D. C. MEMBER A.S.M.E.

THE close relationship between the cost of rendering consulting-engineering services and the proper fees to be charged for such services has been studied for some time by the Committee on Consulting Practice of The American Society cf Mechanical Engineers. Several years ago, a joint meeting was held in Washington, with representatives of national engineering societies and representatives of several federal agencies, to discuss the proper fees for architects and engineers.

The transition from a peacetime economy to a wartime economy has placed the United States Government in the position of being the principal client for consulting engineering services. Subsequent developments have convinced many of us that there is a concerted attempt on the part of this, our principal client, to push fees down lower and lower. To some of us, it looks as if they were probing, not for a floor under fees, but were looking for a subbasement.

It is, of course, the patriotic duty of every citizen during times of war to accept any fee which financial status will permit. Wartime economy should not be used as a means to depress the standard of service, of "know how," or of the economic condition of the consulting engineer. The patriotic acceptance of low fees during wartime should not be made the standard throughout the years to come.

It is reasonable to assume that any man imbued with our kind of democracy will admit that a professional engineer, capable of planning and designing a project which will be useful to a community and which will give work to many other men, is entitled to receive as compensation for his own labor, first, the money he spends in making the plans, and second, an amount for himself commensurate with the magnitude of the undertaking.

The product of a consulting engineer cannot be likened to an article of trade or of standard manufacture but is represented by reports, plans, specifications, and supervision.

The cost of producing these things divides itself into two broad classes, the first of which is the actual cost of drawings and specifications, and this is perhaps the easiest to determine. The second represents the compensation for the engineer's know how, which is much more difficult to establish.

Let us first discuss the actual cost in terms of the elements which enter into its make-up. To produce this product we employ trained men and clerks. We invest capital in machines and devices for these persons to use. We rent space to house the men and devices; we pay salaries; we pay taxes and insurance; we purchase supplies; we use communication systems; we pay interest on invested and borrowed capital. We give our men recreational opportunities so that their efficiency will be maintained. We set up contingency funds so that disappointments will not cripple us. Lastly, we spend money to promote new business so that we can keep our organization together and offer better service to our clients.

When these costs are faithfully recorded no reasonable person can object to them and I will wager that when they are reduced to some common denominator, they will be about the same in all businesses, large or small.

UNIFORM SYSTEM OF ACCOUNTS URGED

To translate these general terms into a common language, it is necessary to express them in a uniform system of accounts. Such a uniform accounting system is helpful, both to the consulting engineer and to his client, for then the elements of true cost are set forth in specific items of dollars expended for specific purposes.

For consideration of the committee formed to consider this problem with the Consulting Engineering Professional Group, I suggest that twelve major classifications of cost be made. These can be further subdivided within their groups when such a requirement is indicated. Subdivisions and multiplications should be avoided to the maximum extent, and simplification should be the rule in any such accounting system.

1. Salaries paid engineers, engineering assistants, and draftsmen.
2. Salaries paid secretaries, stenographers, office clerks, and office help.
3. Office rent.
4. Drafting, stenographic, and office supplies.
5. Taxes and insurance.
6. Communication expense.
7. Blueprinting and duplicating.
8. Expense of travel.
9. Vacations and sick leave for employees.
10. Cost of promoting new work.
11. Depreciation of equipment and library.
12. Interest on invested and borrowed capital.

Item 1 is usually considered the primary item of cost and the remaining eleven are more or less accepted as general expenses. Such general expenses must be prorated if more than one client, or more than one project or consulting engineering activity, is served by an individual or by an organization. The generally accepted basis of prorating such general expenses is to relate them to the first item, namely, salaries paid engineers, engineering assistants, and draftsmen, since such salaries are the best measure of the work done.

Vacations and promotion of new business should be treated as a revolving fund into which payments are made at regular intervals, and from which withdrawals are taken for the two purposes mentioned. Past history is a valuable guide in establishing the annual amount needed for such expenses. If past history is not available, or records have not been kept with sufficient accuracy, then some conservative estimate should be made. It is hoped that the Committee on Costs may be able

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Contributed by the Consulting Engineering Professional Group and presented at the Annual Meeting, New York, N. Y., Nov. 29–Dec. 3, 1943, of The American Society of Mechanical Engineers.

to prepare suggestions which would indicate how much should be set up each month for these important items.

Depreciation of equipment and facilities can be set up according to accepted schedules used for tax or valuation purposes.

Interest on capital invested or borrowed represents the cost of doing business and should be admitted as a cost, but will undoubtedly be subject to some debate as to the proper place for it to appear in the cost or accounting system.

All of these items have been discussed at length in the "Manual of Consulting Practice for Mechanical Engineers," as published by the Society, under the sponsorship of the Committee on Consulting Practice.

I am suggesting the avoidance and abandonment of one convenient term which is used frequently to refer to most of the items in this list. That is the word "overhead." Let us consider that these items are part of cost, since it is not possible to render consulting engineering services without incurring these costs. I suggest, instead of lumping them in one group and expressing them as a percentage of the salaries, that they be considered as general items of cost and prorated individually or in groups in terms of dollars each month as the work progresses, and by setting them up in cost statements under their actual names. There is still much to be said along this line, but further development can best come in open discussions and in the study of the problem by the Committee on Costs.

Some years ago, the relationship of the utility companies to the public resulted in the enforced use of a uniform system of accounts for rendering utility services. Today, we realize in looking backward that this was a major factor that contributed to the stability of the utility field and to the advancement of the science of public utilities. The uniform system of accounts, in effect, translated the business end of public utilities into a common language which can be understood by anyone interested.

Let us then adopt some sort of uniform system of accounts. Let us keep the costs on our new work according to such a system, and if possible, translate the cost of our recent projects or engagements into the system. Once this is done by a number of those engaged in rendering consulting engineering services, the general facts can be assembled by an appropriate group of this committee and the information cleared through our own Society. Thus the public will know what is really involved in planning, designing, and supervising construction projects or in rendering consulting engineering services of an individualized character.

WHAT IS THE PROPER FEE FOR SERVICE?

The second part of our problem is more difficult, for it deals with a controversial question that cannot be easily converted into dollars. The fee to be charged for rendering services, over and above the cost of the services, hinges on one question: What is the proper compensation for engineering know-how?

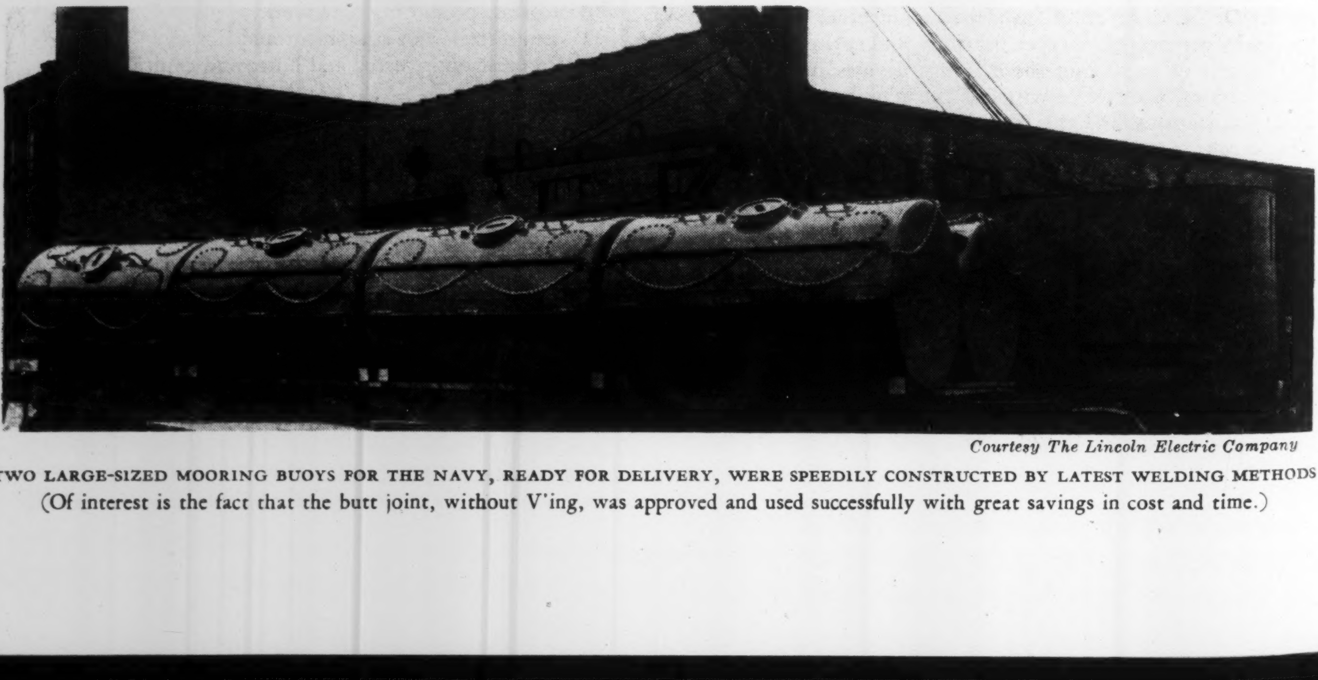
Let us repeat that in time of war our engineering know how is at the disposal of our country. As a profession, we cannot and will not try to force our government to pay more just because it needs our services in a national emergency. When our country requests us to give our services, we are under deep patriotic obligation to respond to this call. Having responded to this call, however, it is unfair and unjust for agents of the national government to tell us what our services are worth without relation to true cost or to true quality.

It is all well enough to say that past history and usage has fixed our proper fees and that the legitimate competition in the profession has established going rates for consulting engineering services. If you study the situation carefully under present conditions, I believe that you will arrive at the same conclusions reached by many of us, that all precedents in the establishment of a proper level of fees have been ignored, and that the fee matter is nothing short of chaotic. It is well, therefore, to try to establish a rational fee schedule for consulting engineering services of various kinds. This might well be studied in relation to the fees paid other professional men and executives; fees that are presently accepted for doctors, lawyers, accountants, marketing counselors, industrial and business leaders.

It may not be easy to draw direct parallels between the services rendered by other professional men and those rendered by consulting engineers. It does seem, however, that the man who can plan and supervise the erection of a project, or guide and advise others to plan and supervise the erection of a public work, which gives jobs to many men and inspiration to thousands for years to come, is worthy of honor and generous compensation.

The man who can, by his knowledge and experience, guide capital into channels which produce ample returns, is worthy of the thanks of capital substantially expressed. The man who, by his ability, and inventive genius, can create productive employment for many, is a benefactor of our social order and is worthy of highest compensation that order can bestow.

All of these statements, dealing with this second part of our problem, have been expressed in the most general of generalities. I believe that the task of the Committee on Costs and of the Consulting Engineering Professional Group should undertake the problem of getting this expressed in dollars. A single individual, or even a small group, cannot accomplish this task alone. The advice and study of all within our Society who are concerned with consulting engineering is needed in this problem. With your co-operation and help, some constructive work can be done.



Courtesy The Lincoln Electric Company

TWO LARGE-SIZED MOORING BUOYS FOR THE NAVY, READY FOR DELIVERY, WERE SPEEDILY CONSTRUCTED BY LATEST WELDING METHODS
(Of interest is the fact that the butt joint, without V'ing, was approved and used successfully with great savings in cost and time.)

MATERIALS STANDARDIZATION[1]

By S. B. ASHKINAZY

STANDARDS ENGINEER, MATERIALS AND PROCESSES, SPERRY GYROSCOPE CO., INC., BROOKLYN, N. Y. MEMBER A.S.M.E.

THE subject of materials standardization is not a new one. As far back as 1892, Charles B. Dudley, in his talk before the American Institute of Mining Engineers, and again in 1903 in his presidential address before the American Society for Testing Materials, clearly expounded the principles of material standards and specifications. Since then, a great deal has been written on the subject and a lot of fine work has been done by the various engineering societies and government agencies in furthering the cause of standardization.

Today, most large companies, and many of the smaller companies, practice materials standardization in some form or other. Materials standardization as practiced at the Sperry Gyroscope Company is unique in many respects, and it is the intent of this paper to discuss some of its outstanding features.

THE MATERIAL STANDARDS MANUAL

The backbone of our materials standardization program is the "Material Standards Manual" which contains complete and up-to-date information on practically all materials used in the company. For each material standardized, a material standard is written embodying the following information: Company identification name, color, and code number; approved sources of supply and complete purchase information; chemical composition; physical, mechanical, and electrical properties; notes on application, characteristics, fabrication, heat-treatment, and corrosion resistance; method of specifying the material on drawings; available commercial forms and sizes; and dimensional tolerances. These material standards are made up on $8^1/_2 \times 11$ in. sheets, printed by the photo-offset process on gray sheets to distinguish them from all other company standards, and assembled in loose-leaf binders forming the "Material Standards Manual." Close to 2000 of these manuals are distributed to practically all engineers, designers, and draftsmen; to personnel in inspection, purchasing, planning, manufacturing, and stores; to prime and subcontractors. The manuals are kept up to date as new standards are added and old ones revised.

One such standard, that on 13 per cent chromium, Type No. 416 free-machining stainless steel, is reproduced here with the permission of the Sperry Gyroscope Company. It is suggested that the reader glance at this sample standard at this point to help him obtain a better understanding of what follows.

SELECTION, FORMS, AND TYPES OF MATERIAL

The first step in the creation of a material standard for our company is the selection of the proper grade of material, the temper, finish, and the like. This is a very important step in the standardization procedure and requires much thought and study. Careful consideration must be given to the following:

Product Requirements. To avoid having too many similar materials, the material selected must be satisfactory for use on the majority of products manufactured. This often necessitates the adoption of a higher grade and more costly material than is actually required for some applications, but experience has shown that such a policy actually results in lower over-all cost and higher production.

Customers' Requirements. The standardized material must in general be of a quality entirely satisfactory to the customer. The customer is interested not only in the performance of the complete product but in its details of construction and use of materials. Since many of our products are sold to the various government agencies, the materials selected must be of the same high quality as the ones covered by government specifications.

Service Requirements. The material selected must possess certain inherent properties which are compatible with the service requirements of the product. Thus by the nature of our products, the material must be able to stand the low temperatures of the stratosphere and the arctic regions, and the high temperatures of the desert. It must be able to withstand the corrosive action of salt air and high-humidity climates.

Availability. It is important that the material standardized on is readily available at all times and in all quantities. It is often necessary to set aside a superior material because there is only one company producing it. If that company should shut down temporarily, production would suffer.

Cost. In some industries, such as those producing low-priced, highly competitive products in mass production, the cost of the materials used may constitute a high percentage of the total cost of the product. In other industries, such as our own, employing highly skilled labor, it is imperative to standardize on materials that will produce a low labor cost rather than a low initial material cost.

Manufacturing Facilities. The capacity and limitations of the shop equipment must also be considered. It would be poor practice to standardize on a material requiring the installation of new equipment when there are other similar materials available that the shop can process.

With the material selected, the first item to be covered in the material standard is that of the available forms of the material, such as rounds, squares, hexagons, flats, sheets, strips, tubing, and wire. Not all of the available forms are listed; only those that have been found necessary and desirable from a design and production standpoint are given. Such a listing at the beginning of the standard enables one to tell at a glance whether the material is available in the desired form.

If more than one type of material is covered in a single standard, a listing of the different types of the material is also given. In our synthetic rubber standard, the five compounds are listed:

Type GPA—General purpose (Shore durometer 55–65)
Type GPB—General purpose (Shore durometer 65–75)
Type LTA—Low-temperature resistant
Type HTA—High-temperature resistant
Type HFA—Hydraulic-fluid resistant.

PURCHASE INFORMATION—PURCHASE FROM

Here, the various sources of supply which were thoroughly investigated and found satisfactory for the supply of the material are listed. The purchasing department may buy only from these approved sources of supply. It can, however, divide the business among the approved suppliers in any way it sees fit. If a supplier complains to the standards engineer that he has not been receiving any business lately, he is told that he is on the approved list and the rest is up to himself and the purchasing department. He is reminded that once he has been approved, the only concern of the standards engineer is the maintenance of the quality of the material. If the quality deteriorates, the standards engineer soon learns about it from sources in the company. The supplier is then investigated and an attempt made to restore the material to its original quality. If the trouble persists, the supplier is removed from the list.

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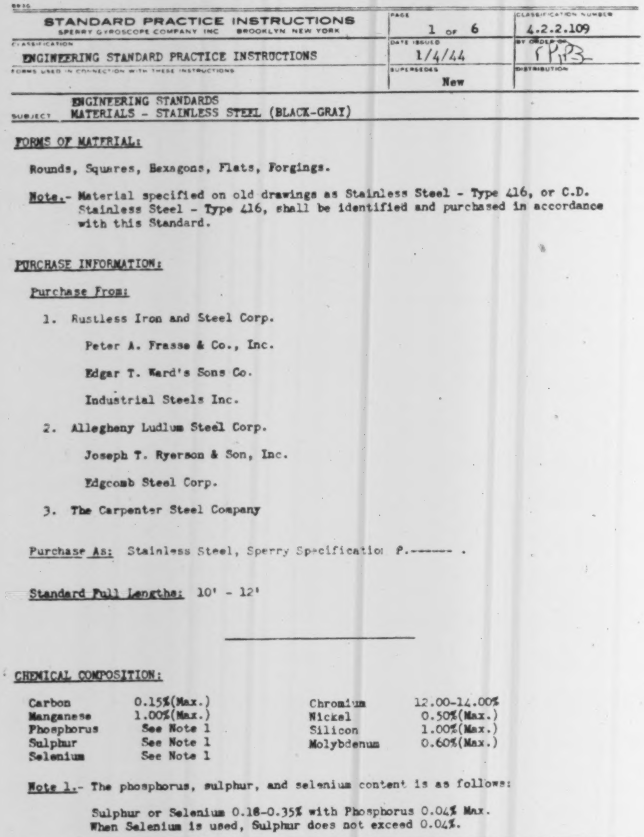
[1] The author gratefully acknowledges the invaluable help and guidance given by A. E. Flad, head of standards, and H. DeJong, design services manager, Sperry Gyroscope Co., in furthering the art of standardization.



STANDARD PRACTICE INSTRUCTIONS SPERRY GYROSCOPE COMPANY INC BROOKLYN NEW YORK	PAGE 1 OF 6	CLASSIFICATION NUMBER 4.2.2.109
CLASSIFICATION ENGINEERING STANDARD PRACTICE INSTRUCTIONS	DATE ISSUED 1/4/44	BY ORDER OF FPB
FORMS USED IN CONNECTION WITH THESE INSTRUCTIONS	SUPERSEDES New	DISTRIBUTION

SUBJECT ENGINEERING STANDARDS
MATERIALS - STAINLESS STEEL (BLACK-GRAY)

FORMS OF MATERIAL:

Rounds, Squares, Hexagons, Flats, Forgings.

Note.- Material specified on old drawings as Stainless Steel - Type 416, or C.D. Stainless Steel - Type 416, shall be identified and purchased in accordance with this Standard.

PURCHASE INFORMATION:

Purchase From:

1. Rustless Iron and Steel Corp.
   Peter A. Frasse & Co., Inc.
   Edgar T. Ward's Sons Co.
   Industrial Steels Inc.
2. Allegheny Ludlum Steel Corp.
   Joseph T. Ryerson & Son, Inc.
   Edgcomb Steel Corp.
3. The Carpenter Steel Company

Purchase As: Stainless Steel, Sperry Specificatio P.------ .

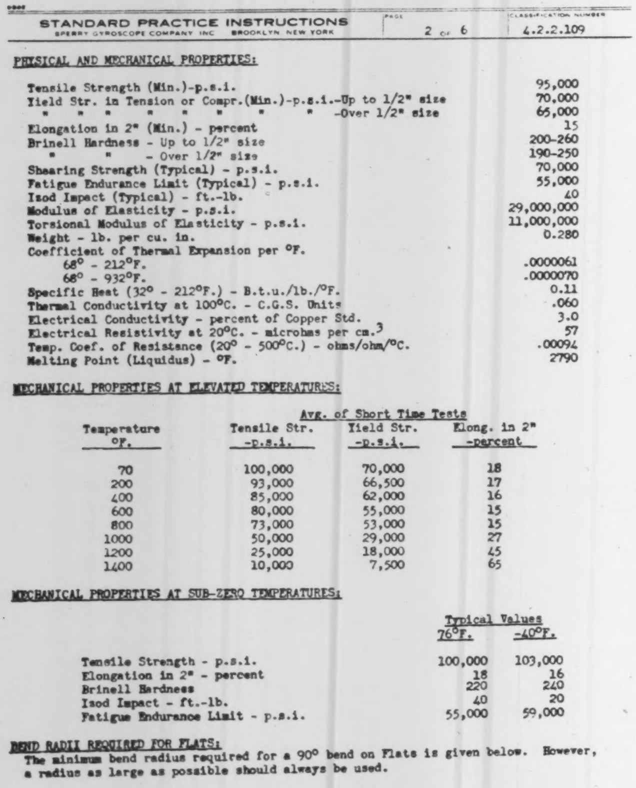
Standard Full Lengths: 10' - 12'

CHEMICAL COMPOSITION:

Carbon	0.15%(Max.)	Chromium	12.00-14.00%
Manganese	1.00%(Max.)	Nickel	0.50%(Max.)
Phosphorus	See Note 1	Silicon	1.00%(Max.)
Sulphur	See Note 1	Molybdenum	0.60%(Max.)
Selenium	See Note 1		

Note 1.- The phosphorus, sulphur, and selenium content is as follows:

Sulphur or Selenium 0.18-0.35% with Phosphorus 0.04% Max.
When Selenium is used, Sulphur does not exceed 0.04%.



STANDARD PRACTICE INSTRUCTIONS SPERRY GYROSCOPE COMPANY INC BROOKLYN NEW YORK	PAGE 2 OF 6	CLASSIFICATION NUMBER 4.2.2.109

PHYSICAL AND MECHANICAL PROPERTIES:

Tensile Strength (Min.)-p.s.i.	95,000
Yield Str. in Tension or Compr.(Min.)-p.s.i.-Up to 1/2" size	70,000
" " " " " " " " -Over 1/2" size	65,000
Elongation in 2" (Min.) - percent	15
Brinell Hardness - Up to 1/2" size	200-260
" " - Over 1/2" size	190-250
Shearing Strength (Typical) - p.s.i.	70,000
Fatigue Endurance Limit (Typical) - p.s.i.	55,000
Izod Impact (Typical) - ft.-lb.	40
Modulus of Elasticity - p.s.i.	29,000,000
Torsional Modulus of Elasticity - p.s.i.	11,000,000
Weight - lb. per cu. in.	0.280
Coefficient of Thermal Expansion per °F.	
68° - 212°F.	.0000061
68° - 932°F.	.0000070
Specific Heat (32° - 212°F.) - B.t.u./lb./°F.	0.11
Thermal Conductivity at 100°C. - C.G.S. Units	.060
Electrical Conductivity - percent of Copper Std.	3.0
Electrical Resistivity at 20°C. - microhms per cm.^{3}	57
Temp. Coef. of Resistance (20° - 500°C.) - ohms/ohm/°C.	.00094
Melting Point (Liquidus) - °F.	2790

MECHANICAL PROPERTIES AT ELEVATED TEMPERATURES:

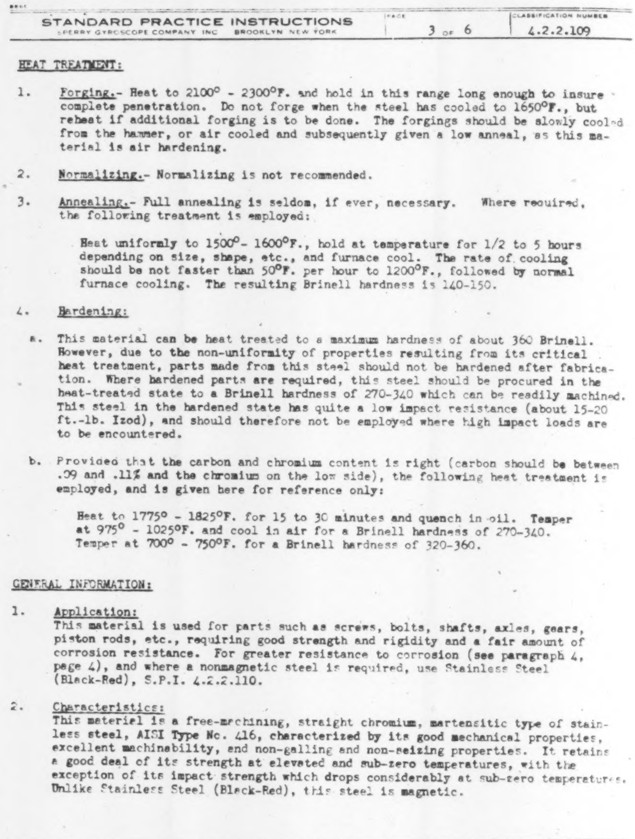
	Avg. of Short Time Tests		
Temperature °F.	Tensile Str. -p.s.i.	Yield Str. -p.s.i.	Elong. in 2" -percent
70	100,000	70,000	18
200	93,000	66,500	17
400	85,000	62,000	16
600	80,000	55,000	15
800	73,000	53,000	15
1000	50,000	29,000	27
1200	25,000	18,000	45
1400	10,000	7,500	65

MECHANICAL PROPERTIES AT SUB-ZERO TEMPERATURES:

	Typical Values	
	76°F.	-40°F.
Tensile Strength - p.s.i.	100,000	103,000
Elongation in 2" - percent	18	16
Brinell Hardness	220	240
Izod Impact - ft.-lb.	40	20
Fatigue Endurance Limit - p.s.i.	55,000	59,000

BEND RADII REQUIRED FOR FLATS:
The minimum bend radius required for a 90° bend on Flats is given below. However, a radius as large as possible should always be used.

Min. Bend Radius = Thickness of Flat



STANDARD PRACTICE INSTRUCTIONS SPERRY GYROSCOPE COMPANY INC BROOKLYN NEW YORK	PAGE 3 OF 6	CLASSIFICATION NUMBER 4.2.2.109

HEAT TREATMENT:

1. Forging.- Heat to 2100° - 2300°F. and hold in this range long enough to insure complete penetration. Do not forge when the steel has cooled to 1650°F., but reheat if additional forging is to be done. The forgings should be slowly cooled from the hammer, or air cooled and subsequently given a low anneal, as this material is air hardening.

2. Normalizing.- Normalizing is not recommended.

3. Annealing.- Full annealing is seldom, if ever, necessary. Where required, the following treatment is employed:

   Heat uniformly to 1500°- 1600°F., hold at temperature for 1/2 to 5 hours depending on size, shape, etc., and furnace cool. The rate of cooling should be not faster than 50°F. per hour to 1200°F., followed by normal furnace cooling. The resulting Brinell hardness is 140-150.

4. Hardening:

   a. This material can be heat treated to a maximum hardness of about 360 Brinell. However, due to the non-uniformity of properties resulting from its critical heat treatment, parts made from this steel should not be hardened after fabrication. Where hardened parts are required, this steel should be procured in the heat-treated state to a Brinell hardness of 270-340 which can be readily machined. This steel in the hardened state has quite a low impact resistance (about 15-20 ft.-lb. Izod), and should therefore not be employed where high impact loads are to be encountered.

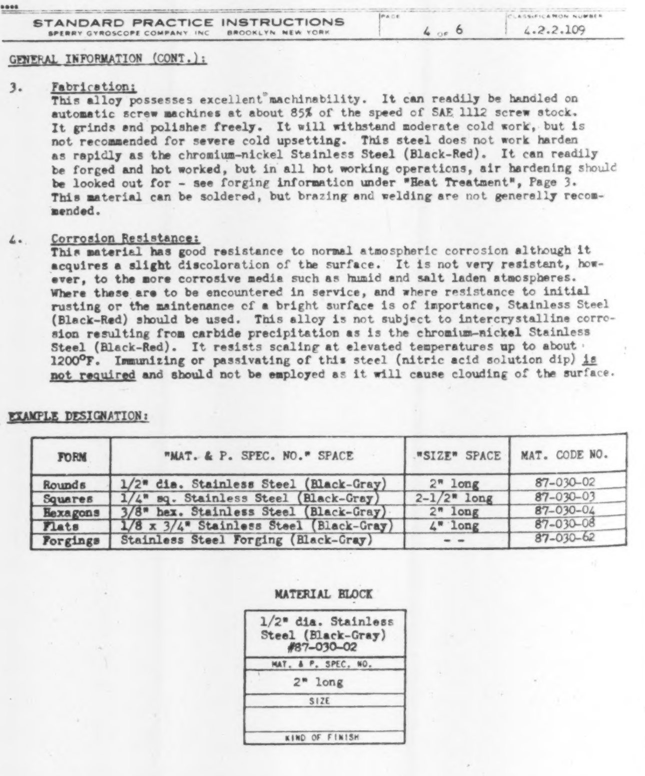
   b. Provided that the carbon and chromium content is right (carbon should be between .09 and .11% and the chromium on the low side), the following heat treatment is employed, and is given here for reference only:

      Heat to 1775° - 1825°F. for 15 to 30 minutes and quench in oil. Temper at 975° - 1025°F. and cool in air for a Brinell hardness of 270-340. Temper at 700° - 750°F. for a Brinell hardness of 320-360.

GENERAL INFORMATION:

1. Application:
   This material is used for parts such as screws, bolts, shafts, axles, gears, piston rods, etc., requiring good strength and rigidity and a fair amount of corrosion resistance. For greater resistance to corrosion (see paragraph 4, page 4), and where a nonmagnetic steel is required, use Stainless Steel (Black-Red), S.P.I. 4.2.2.110.

2. Characteristics:
   This material is a free-machining, straight chromium, martensitic type of stainless steel, AISI Type No. 416, characterized by its good mechanical properties, excellent machinability, and non-galling and non-seizing properties. It retains a good deal of its strength at elevated and sub-zero temperatures, with the exception of its impact strength which drops considerably at sub-zero temperatures. Unlike Stainless Steel (Black-Red), this steel is magnetic.



STANDARD PRACTICE INSTRUCTIONS SPERRY GYROSCOPE COMPANY INC BROOKLYN NEW YORK	PAGE 4 OF 6	CLASSIFICATION NUMBER 4.2.2.109

GENERAL INFORMATION (CONT.):

3. Fabrication:
   This alloy possesses excellent machinability. It can readily be handled on automatic screw machines at about 85% of the speed of SAE 1112 screw stock. It grinds and polishes freely. It will withstand moderate cold work, but is not recommended for severe cold upsetting. This steel does not work harden as rapidly as the chromium-nickel Stainless Steel (Black-Red). It can readily be forged and hot worked, but in all hot working operations, air hardening should be looked out for - see forging information under "Heat Treatment", Page 3. This material can be soldered, but brazing and welding are not generally recommended.

4. Corrosion Resistance:
   This material has good resistance to normal atmospheric corrosion although it acquires a slight discoloration of the surface. It is not very resistant, however, to the more corrosive media such as humid and salt laden atmospheres. Where these are to be encountered in service, and where resistance to initial rusting or the maintenance of a bright surface is of importance, Stainless Steel (Black-Red) should be used. This alloy is not subject to intercrystalline corrosion resulting from carbide precipitation as is the chromium-nickel Stainless Steel (Black-Red). It resists scaling at elevated temperatures up to about 1200°F. Immunizing or passivating of this steel (nitric acid solution dip) is not required and should not be employed as it will cause clouding of the surface.

EXAMPLE DESIGNATION:

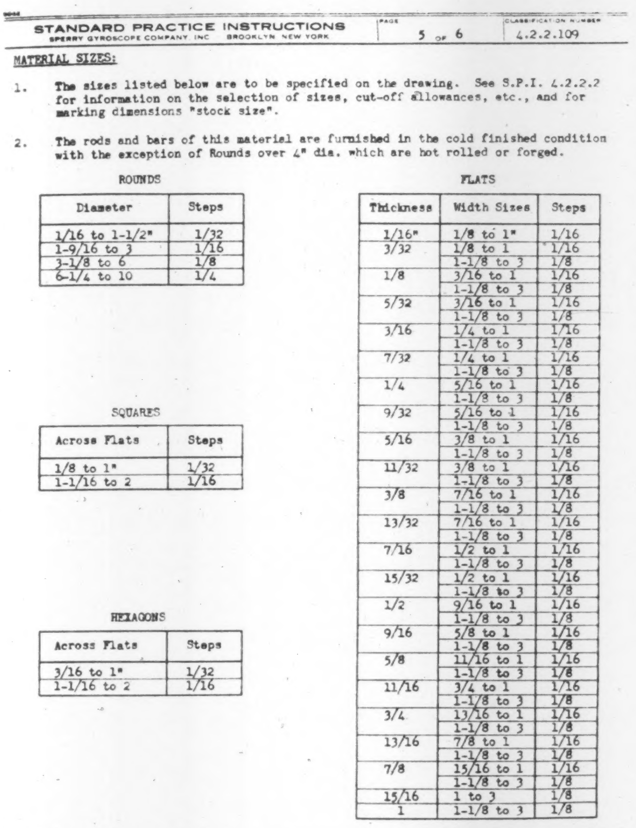
FORM	"MAT. & P. SPEC. NO." SPACE	"SIZE" SPACE	MAT. CODE NO.
Rounds	1/2" dia. Stainless Steel (Black-Gray)	2" long	87-030-02
Squares	1/4" sq. Stainless Steel (Black-Gray)	2-1/2" long	87-030-03
Hexagons	3/8" hex. Stainless Steel (Black-Gray)	2" long	87-030-04
Flats	1/8 x 3/4" Stainless Steel (Black-Gray)	4" long	87-030-08
Forgings	Stainless Steel Forging (Black-Gray)	- -	87-030-62

MATERIAL BLOCK

1/2" dia. Stainless Steel (Black-Gray) #87-030-02
MAT. & P. SPEC. NO.
2" long
SIZE
KIND OF FINISH

Note.- Finish #29 (Immunizing Treatment) shall not be specified for this material - see paragraph #4 above.

SIX FACSIMILE PAGES (TWO ON OPPOSITE PAGE) OF A TYPICAL MATERIAL STANDARD OF THE SPERRY GYROSCOPE COMPANY FOR 13 PER CENT CHROMIUM, TYPE NO. 416, FREE-MACHINING STAINLESS STEEL



STANDARD PRACTICE INSTRUCTIONS
SPERRY GYROSCOPE COMPANY, INC. BROOKLYN NEW YORK
PAGE 5 OF 6
CLASSIFICATION NUMBER 4.2.2.109

MATERIAL SIZES:

1. The sizes listed below are to be specified on the drawing. See S.P.I. 4.2.2.2 for information on the selection of sizes, cut-off allowances, etc., and for marking dimensions "stock size".

2. The rods and bars of this material are furnished in the cold finished condition with the exception of Rounds over 4" dia. which are hot rolled or forged.

ROUNDS

Diameter	Steps
1/16 to 1-1/2"	1/32
1-9/16 to 3	1/16
3-1/8 to 6	1/8
6-1/4 to 10	1/4

SQUARES

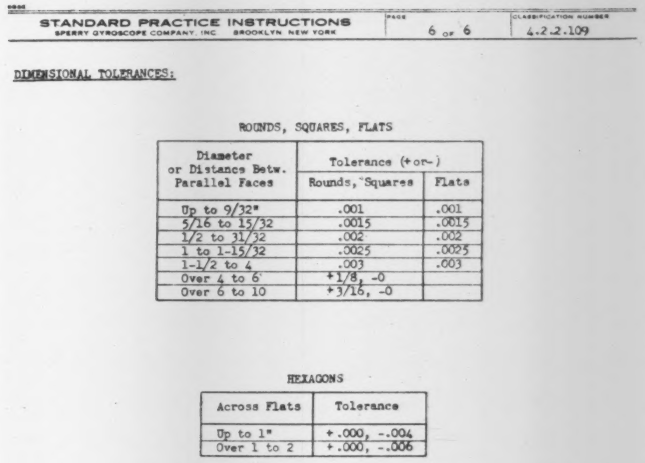
Across Flats	Steps
1/8 to 1"	1/32
1-1/16 to 2	1/16

HEXAGONS

Across Flats	Steps
3/16 to 1"	1/32
1-1/16 to 2	1/16

FLATS

Thickness	Width Sizes	Steps
1/16"	1/8 to 1"	1/16
3/32	1/8 to 1	1/16
	1-1/8 to 3	1/8
1/8	3/16 to 1	1/16
	1-1/8 to 3	1/8
5/32	3/16 to 1	1/16
	1-1/8 to 3	1/8
3/16	1/4 to 1	1/16
	1-1/8 to 3	1/8
7/32	1/4 to 1	1/16
	1-1/8 to 3	1/8
1/4	5/16 to 1	1/16
	1-1/8 to 3	1/8
9/32	5/16 to 1	1/16
	1-1/8 to 3	1/8
5/16	3/8 to 1	1/16
	1-1/8 to 3	1/8
11/32	3/8 to 1	1/16
	1-1/8 to 3	1/8
3/8	7/16 to 1	1/16
	1-1/8 to 3	1/8
13/32	7/16 to 1	1/16
	1-1/8 to 3	1/8
7/16	1/2 to 1	1/16
	1-1/8 to 3	1/8
15/32	1/2 to 1	1/16
	1-1/8 to 3	1/8
1/2	9/16 to 1	1/16
	1-1/8 to 3	1/8
9/16	5/8 to 1	1/16
	1-1/8 to 3	1/8
5/8	11/16 to 1	1/16
	1-1/8 to 3	1/8
11/16	3/4 to 1	1/16
	1-1/8 to 3	1/8
3/4	13/16 to 1	1/16
	1-1/8 to 3	1/8
13/16	7/8 to 1	1/16
	1-1/8 to 3	1/8
7/8	15/16 to 1	1/16
	1-1/8 to 3	1/8
15/16	1 to 3	1/8
1	1-1/8 to 3	1/8



STANDARD PRACTICE INSTRUCTIONS
SPERRY GYROSCOPE COMPANY, INC. BROOKLYN NEW YORK
PAGE 6 OF 6
CLASSIFICATION NUMBER 4.2.2.109

DIMENSIONAL TOLERANCES:

ROUNDS, SQUARES, FLATS

Diameter or Distance Betw. Parallel Faces	Tolerance (+ or -)	
	Rounds, Squares	Flats
Up to 9/32"	.001	.001
5/16 to 15/32	.0015	.0015
1/2 to 31/32	.002	.002
1 to 1-15/32	.0025	.0025
1-1/2 to 4	.003	.003
Over 4 to 6	+1/8, -0	
Over 6 to 10	+3/16, -0	

HEXAGONS

Across Flats	Tolerance
Up to 1"	+.000, -.004
Over 1 to 2	+.000, -.006

The standards engineer works closely with the purchasing department in setting up the approved sources of supply. When a material is standardized, the prospective list of manufacturers is submitted to the purchasing department for comment. The purchasing department is asked to submit the names of any other manufacturers to whom consideration should be given. If, after a standard is released, the purchasing department finds that it needs more sources of supply, it requests that additional suppliers be investigated and approved.

The practice of purchasing materials from lists of approved suppliers has many advantages. It provides the purchasing department with ready sources of supply for each material, thereby facilitating the placing of orders and the obtaining of quick deliveries. It gives the purchasing department that security which comes from knowing that it is buying from vendors whose facilities and capacity to produce have been surveyed, and who have been instructed fully in regard to the requirements of the material.

The benefits derived by the standards engineer are likewise numerous. It enables him to exercise full control over the quality of the materials. Since he investigates and approves all vendors, he comes in contact with the personnel of the manufacturers seeking our business and thereby receives a steady stream of information on new and improved materials. It also helps him to obtain the technical information needed for the writing of the standard, as the manufacturers are dependent on him for approval.

PURCHASE INFORMATION—PURCHASE AS

Following the listing of the approved sources of supply, complete information for the purchasing of the material is given. The purchasing information is arranged so that the exact wording can be copied onto the purchase order. The buyer is thus assured of the correct purchase information at all times, eliminating uncertainty and confusion.

In setting up the purchasing information, an attempt is made to employ existing material specifications that are recognized as standard throughout the country. The most widely used are the A.S.T.M. specifications. When none of the existing specifications fulfills our requirements, we write our own specifications.

A great deal has been written in the past about the preparation, interpretation, use, and advantages of material specifications. A number of fine treatises on this subject are listed at the end of this paper. It will suffice to state here that specifications should be written to give complete coverage for the procurement and inspection of the material and yet not to be so rigid or so impracticable that they are impossible of fulfillment. They must be clearly written, free of unimportant details, and in a manner that leaves little room for misinterpretation. Specifications should be revised whenever it is advantageous to do so.

PURCHASE INFORMATION—STANDARD FULL WIDTHS AND LENGTHS

To complete the purchase information, the widths and lengths to which the different forms of the material are to be procured for stock are given. The selection of these widths and lengths is based on a number of considerations. They must adequately cover width and length requirements of parts manufactured; they must lend themselves to economic operation of screw machines, power presses, and the like; they must fit our stock bins; they must be readily available from the mill and the warehouse; and they must not involve high-price "extras." In selecting width sizes of sheets, consideration must also be given to resulting thickness tolerances.

CHEMICAL COMPOSITION

The complete chemical composition as it normally appears in the purchase specification is also listed for reference. This enables the person using the standard to obtain the composition without having to draw the purchase specification from the files. For nonmetallic and other materials that do not lend themselves to complete chemical analysis, a listing of the chief constituents is given instead. Thus, the chemical composition of plate glass is given as follows: Silicon dioxide (SiO_2), 70 per cent; sodium oxide (Na_2O), 13 per cent; calcium oxide (CaO), 13 per cent; other substances, 4 per cent.

The chemical composition of cellulose acetate is described as "ester of alpha cellulose and acetic acid," and so on.

PHYSICAL AND MECHANICAL PROPERTIES

A complete listing of the physical and mechanical properties applicable to the material is given. The properties normally covered are as follows: Tensile strength, yield strength in tension and compression, elongation in 2 in., hardness, shearing strength, fatigue strength, impact strength, modulus of elasticity in tension and torsion, weight or specific gravity, coefficient of thermal expansion for various temperature ranges, thermal conductivity, specific heat, electrical conductivity, electrical resistivity, temperature coefficient of resistance, melting point, dielectric constant, power factor, loss factor, dielectric strength, water absorption, softening point, heat resistance, and others.

The values listed are compiled mainly from data received from the manufacturers of the material. The manufacturers do not always have all of the values we seek. When that is the case, they are requested to undertake additional testing of their materials. At times, our own laboratory determines some of the missing values. A search of the literature on researches undertaken by the various engineering societies may also produce some of the desired information. Regardless of the source, however, the values listed are the most reliable for design purposes. Minimum values are given wherever they are available, and average or typical values for all others.

Since many of our products operate at elevated and subzero temperatures in service, a knowledge of the properties of the material at those temperatures is of extreme importance to our designers. The more important mechanical properties of the material at elevated and subzero temperatures are therefore given.

BEND RADII

The minimum bend radii required to make a 90-deg bend in flats, sheets, strips, and tubing are listed. The draftsman is cautioned, however, that a radius as large as possible should always be specified. For sheets and strips, the radii for bending with and across the grain are given. This helps the draftsman and the methods engineer to lay out his blank in relation to the direction of the grain for best formability.

HEAT-TREATMENT

The various thermal treatments applicable to the material are listed. Complete information is given on forging, normalizing, annealing, hardening, tempering, case hardening, and stress relieving. The treatments listed constitute the best practice for the material. The methods engineer in writing operation sheets quotes directly from the standard, or refers the heat treater to the information given in the material standard.

GENERAL INFORMATION

Under "General Information," the application, characteristics, fabrication, and corrosion resistance of the material, and other miscellaneous subjects are treated.

Application. Various uses to which the material can be put are listed and the shortcomings or limitations of the material from the application standpoint are also given. If more than one type of material or more than one temper are covered in the same standard, the use of each is clearly delineated. Reference is made to other standard materials in the Manual which are superior in certain respects for the application under discussion.

Characteristics. The mechanical, chemical, thermal, electrical, and other special characteristics of the material are described. The commercial designation of the material, method of manufacture, and surface finish are also noted.

Fabrication. Each material is given a machinability rating. Ferrous alloys are compared to S.A.E. 1112 screw stock and nonferrous alloys to free-cutting brass. The suitability of the material for cold and hot working, stamping, forming, swaging, and peening is discussed. Recommendations for welding, brazing, and soldering of the material are also included. Special precautions to be taken and things to watch during fabrication which may deleteriously affect the material are noted.

Corrosion Resistance. In describing the corrosion resistance of the material, an evaluation is given of the resistance of the material to general atmospheric, marine, and other types of corrosion. Chemical corrosion and corrosion by the electrolytic action of dissimilar metals are also discussed. Protective treatments, electroplates, and organic coatings that may be applied to the material to enhance its corrosion resistance are listed.

Miscellaneous Subjects. In addition to the foregoing, other miscellaneous subjects are treated. For example, in the standard on blue tempered spring steel, the effect of ground and polished edges on the fatigue-life of flat springs is treated. In the standard on phenolic molding materials, something is said about the principles of good molding design. Similarly, other topics pertaining to the material are discussed.

EXAMPLE DESIGNATION

Here the exact manner in which the material is to be specified on the drawing is given. Most materials are designated on drawings by company names rather than by commercial brand names. This permits the adoption of improved materials at a future date without the necessity of changing drawings. For example, our low-temperature synthetic rubber stock is designated on the drawing as "Synthetic Rubber—Type LTA." At the present time this material is produced from a Neoprene Type FR polymer. If at some future date a superior low-temperature stock is developed from some other basic material, such as a butadiene stock, the material standard can be revised to call for the new material without changing the existing designation, and hence without changing drawings.

MATERIAL SIZES

All standardized sizes for use in design are listed. The range of sizes and the number of sizes selected are based on product requirements and good design practice. When a draftsman is unable to use any of the sizes listed, he inquires of the standards engineer whether he may specify the nonstandard size. This gives the standards engineer the opportunity to see the design and discuss with the draftsman the wisdom of designing around a nonstandard size. The number of special sizes issued is thus held to a minimum.

The sizes listed are those which can be manufactured at the mill. Many of these are also available from warehouse stock. No attempt is made, however, to standardize around warehouse stock sizes only, as such sizes change from day to day and are usually limited in range. If the size required is not available from warehouse stock, and the quantity or delivery date does not permit mill fabrication, the methods engineer may authorize the procurement of a warehouse stock size slightly larger than that specified on the drawing to permit machining down to the specified size.

DIMENSIONAL TOLERANCES

For every material size listed in the standard, the corresponding commercial tolerance is given. The commercial tolerances are not specified on the drawing as it is understood that, unless otherwise specified, material "stock" sizes are governed by the commercial tolerances listed in the standard. All incoming materials are inspected to these tolerances.

When the commercial tolerance cannot be utilized in a design, the special tolerance must be specified on the drawing. Here again, the draftsman consults with the standards engineer on the feasibility of specifying the special tolerance. The practice of designing around special tolerances is greatly discouraged as it involves difficulty in procurement and stocking.

PRODUCT ENGINEER HAS FINAL AUTHORITY IN USE OF STANDARD MATERIALS

In the foregoing description, the author has endeavored to show in detail what constitutes a material standard at the Sperry Gyroscope Company. It can readily be seen that the information published for each material standardized is quite complete. With these Standards at their disposal, the engineer, designer, draftsman, purchasing agent, inspector, shop foreman, and other company personnel can find the specific information they may seek about the material.

The use of standard materials is almost entirely on a voluntary basis. The product engineer has the final authority in the selection of his materials. The success of the standardization program therefore lies in the ability to make the engineer want to specify standard materials. This is done, first of all, by making the standards work of such quality and technical excellence that it will have the respect of the engineers, and secondly, by placing the information at the tips of their fingers.

In spite of the voluntary nature, standardization of this kind has resulted in the use of standard materials in more than 90 per cent of our material requirements. The other 10 per cent of the material requirements are also controlled by the standards engineer. For materials not covered in the manual, the draftsman has to consult the standards engineer for information on sizes, material code number, correct drawing designation, and the like. This procedure makes it possible for the standards engineer to question each new material and to make recommendations for the use of standard materials.

STANDARDS ENGINEER ADVISES ON USE OF NONSTANDARD MATERIAL

In addition to the published work, there are many other ways in which the engineers, designers, draftsmen, and other company personnel are made "standards conscious." For one thing, they are encouraged to bring their material problems to the standards engineer. From the mass of information accumulated over a period of years, and from the experience and specialized training in materials and metallurgy, finishes and shop processes, tool and die work, design, and the like, the standards engineer is in an excellent position to render immediate and effective service. If he does not know the answer to a problem, he makes it his business to find the answer. Thus he may make a search of the literature on the subject, consult outside firms, call in experts, and run experiments in the laboratory. The important point is that he finds the right answer. Unless the men receive prompt and satisfactory solutions, they will not bother coming back again. In winning the confidence of the engineers, the standards engineer is able to "get in on the ground floor" and exert his influence in the research and development stage, making his task that much easier when the project gets to the production stage.

The Standards Department maintains complete files of government specifications; A.S.T.M., A.S.M.E., S.A.E., A.M.S., A.I.S.I., N.E.M.A., A.S.A., and other nationally issued standards and specifications; commercial catalogs; and technical literature. It maintains sample cabinets containing displays on materials and finishes. Engineers and other personnel are urged to make use of these facilities.

The standards engineer carries on various educational programs on materials standardization. He gives informal lectures to many groups throughout the company, publishes articles in the department bulletin, and arranges for short talks by outside specialists.

Another important factor contributing to the success of the program is the well-defined policy of the management on company standards. Clear directives from engineering executives properly publicized furnish indispensable support to standards efforts.

ADVANTAGES OF STANDARDIZATION

From what has been said thus far, it can be concluded that materials standardization has the following advantages:

1 It sets up a uniform system for everybody to follow.

2 It guides those concerned with specifying, requisitioning, purchasing, stocking, and inspecting of materials.

3 It permits the specification of materials on drawings in such a manner that changes in them will not require changes in drawings.

4 It permits the exercise of proper control over the quality of materials.

5 It establishes standards of quality and effectiveness of the finished product.

6 It confines use of materials to as few as possible, based on functional requirements rather than individual preferences.

7 It simplifies records kept throughout the company as there are fewer types, sizes, etc. to be recorded.

8 It avoids lost motion and confusion in requisitioning and purchasing of materials.

9 It permits the purchasing of fewer items and in greater quantities for best economy.

10 It reduces the amount of capital tied up in inventory.

11 It simplifies storage.

12 It reduces manufacturing costs.

13 It shortens fabrication time.

14 It eliminates duplication of effort.

15 It eliminates waste.

16 It facilitates design and development work.

17 It stimulates research and makes for the elimination of antiquated methods and materials.

18 It reduces cost and time of instruction of new employees.

REFERENCES

1 "The Making of Specifications for Structural Materials," by C. B. Dudley, Trans. American Institute of Mining and Metallurgical Engineers, vol. 21, 1892–1893, pp. 379–394.

2 "The Making of Specifications for Materials," by C. B. Dudley, Proceedings of the American Society for Testing Materials, 1903, p. 15.

3 "The Enforcement of Specifications," by C. B. Dudley, Proceedings of the American Society for Testing Materials, 1907, p. 19.

4 "The Purchase of Materials on Specification," by D. Harvey, Proceedings of the American Society for Testing Materials, vol. 25, 1925, part 2, pp. 425–441.

5 "Standards and Standardization," by N. F. Harriman, McGraw-Hill Book Co., Inc., New York, N. Y., 1928.

6 "Specifications From the Standpoint of a Large Purchaser of Engineering and Special Materials," by J. W. Bancker, Proceedings of the American Society for Testing Materials, 1931, part 2, p. 987.

7 "Economic Control of Engineering and Manufacturing," by Frank L. Eidmann, McGraw-Hill Book Co., Inc., 1931.

8 "The Standardization Work of the Detroit Edison Company," by F. M. Price, American Standards Association Bulletin, vol. 3, 1932, pp. 47–59, 85–97, and 111–122.

9 "Planning for Collection of Standardization Data," by J. R. Townsend, Proceedings of the American Society for Testing Materials, vol. 33, part 2, 1933, pp. 770–785.

10 "Industrial Standardization," by J. Gaillard, H. W. Wilson Company, New York, N. Y., 1934.

11 "Some Fundamentals in Standardization," by F. B. Jewett, *Industrial Standardization*, vol. 8, 1937, pp. 323–325, and 328–330.

12 "Fundamentals of Standards and Specifications," by H. P. Sellye, Edison Electric Institute Bulletin, vol. 5, no. 3, Mar., 1937, pp. 75, 76.

13 "Material Standardization," by F. G. Jenkins, *Iron Age*, vol. 147, Feb. 20, 1941, pp. 35–39, and Feb. 27, 1941, pp. 52–55.

14 "Material Specification Principles," by F. G. Jenkins, Mechanical Engineering, vol. 63, 1941, pp. 900–903.

15 "Aspects of Practical Standardization," by B. C. Boulton, *Aero Digest*, vol. 39, no. 6, Dec., 1941, pp. 217–222.

16 "Symposium on Standardization," *Refrigerator Engineering*, vol. 43, no. 4, April, 1942, pp. 223–226.

17 "How Standards are Used in Army Procurement," by B. A. Falk, *Industrial Standardization*, vol. 13, no. 6, June, 1942, pp. 158, 159.

18 "War-Time Problems of Company Standards Department," by L. F. Adams, *Industrial Standardization*, June, 1942, p. 164.

19 "Benefits of Material Standardization," by F. G. Jenkins, Mechanical Engineering, vol. 64, no. 7, July, 1942, pp. 545–548.

MECHANICS *of* INJURY *Under* FORCE CONDITIONS

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IN 1941 there were about 20,000 airplanes in use by civilians. During that year there were 2875 accidents requiring major overhaul of the aircraft. In addition, there were 411 accidents in which the aircraft was damaged beyond repair. Of the 1000 persons injured in these accidents, 564 suffered serious or fatal injury. Looking at the past, this is not a bad record—but it gives rise to serious concern for the future.

One hundred thousand civil aircraft is the conservative estimate of postwar expansion and 300,000 is the hope of manufacturers who are optimistic about future developments.

It is certainly doubtful that a tenfold expansion in civilian use of aircraft can be realized if this expansion of flying brings with it large numbers of accidents in which fatal or serious injuries are sustained.

If the present ratio of fatal injuries is maintained, it will mean that about as many people would be killed in 300,000 private aircraft as were killed in 1941 in 6,000,000 automobiles.

Whether large postwar expansions can be achieved will depend, above all things, on whether postwar aircraft are conspicuously dangerous or conspicuously safe. Limited controls, reasonable speeds, and spin-proof planes are indications of the industry's thought on the safety side. These characteristics doubtless will reduce the percentage of fatal accidents which in the past have resulted from spins and pilot technique. A large increase in the percentage of moderate and severe accidents must be anticipated as a part of the future, for safe flying depends on experience, judgment, and constant practice. Lack of practice alone, in the past, has always led to greatly increased dangers for part-time and "week-end" pilots.

Looking toward the future, and with the thought that greater safety could be provided by manufacturers if causes of injury were known, surveys were inaugurated in 1942 by the Civil Aeronautics Board with the object of finding injury facts and determining what number of crashes are survivable. Since that time, causes of injury have been studied and reported to the Safety Bureau of the C.A.B. wherever possible after careful investigation of each accident.

From this work 30 light-aircraft accidents have recently been analyzed as a pilot study. Details of each accident and medical data on the resulting injuries were reported to a project for crash injury research recommended by the Committee on Aviation Medicine of the National Research Council and approved by the Committee on Medical Research of the Office of Scientific Research and Development. A summary of a report made after studying these accidents follows:

"Thirty survivable light-aircraft accidents were analyzed on the basis of resulting injuries. Tandem seat crashes in which forward and rearward seats were occupied were selected for study in order to *compare the injuries caused by two different structural environments in the same accident.*

"Trends of the study indicate that:

(*a*) The force of many accidents now fatal is well within physiological limits of survival.

(*b*) Needless injuries—both serious and fatal—are caused by the unfortunate placement and design of certain objects and structures.

"Although light-plane accidents only were included in this study, the force-injury relationship of these crashes approximates that of pursuit plane and bomber accidents in which the crash speed is stopped through longer distances."

It was noted in this study that a large percentage of 2-in. seat belts failed to hold the victims of these accidents and that the belt, its sewings, and fastenings were completely inadequate to meet severe crash strains. On the other hand, whereas many belts and fastenings were broken by the severe force of the accidents the victims of these accidents showed unexpected and amazing strength in resisting the abrupt, snubbing action of the seat belt. Of all important injuries among 51 survivors of these accidents internal-abdominal unjury was found to be the least frequent.

Where the belt fastenings were anchored to the seats, seat-fastenings, both of the fixed and sliding type, were torn away in many accidents and pilots and passengers were catapulted against various structures with disastrous results. Axiomatically, there was an outstanding amount of unnecessary injury resulting from solid structural objects placed in front of, and adjacent to, the occupants. Constantly where the belt and its anchorage held, placement of objects within forward range of the head caused a high percentage of serious and fatal head injuries and broken necks. Exposed steel braces, tube clusters, seat backs, the instrument panel and its supports were so arranged in many types of aircraft as to scarcely allow a chance of survival even in moderately severe emergency or crash conditions.

Added to other hazards, seats collapsed under heavy downward pressure causing unnecessarily severe injury in many crashes. No imagination is required on the seriousness of partial collapse of inadequate seat structure under downward pressure of a thousand or more pounds.

This failure to provide a reasonable degree of protection for pilot and passenger under the force conditions of accidents is not limited to civilian aircraft nor are the findings limited to civilian study groups. Army, Navy, and R.A.F. crash study sections are constantly watching the results of accidents in the Services and are noting failures to properly stress the fastenings of seats, belts, harness, armor plate, and other structure to meet survivable crash forces.

Although it is obvious that more can be done to provide emergency or crash safety in civilian planes than in military aircraft, the trend of reports to date indicates that some manufacturers of civil aircraft are putting too much attention on flight characteristics and efficiency, and letting definite setups for injury take a sure mechanical toll in accidents.

If failure of structure causes loss of a wing under reasonable conditions of flight, something very definite is done to strengthen the design and prevent future injury from this cause. But if seats tear loose in survivable accidents or if fatal head injuries are caused repeatedly by the bad placement of forward

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This review was made under a contract recommended by the Committee on Medical Research, between the Office of Scientific Research and Development and Cornell University Medical College.

Contributed by the Committee on Biomechanics of the Aviation Division and presented at the Annual Meeting, New York, N. Y., Nov. 29–Dec. 3, 1943, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

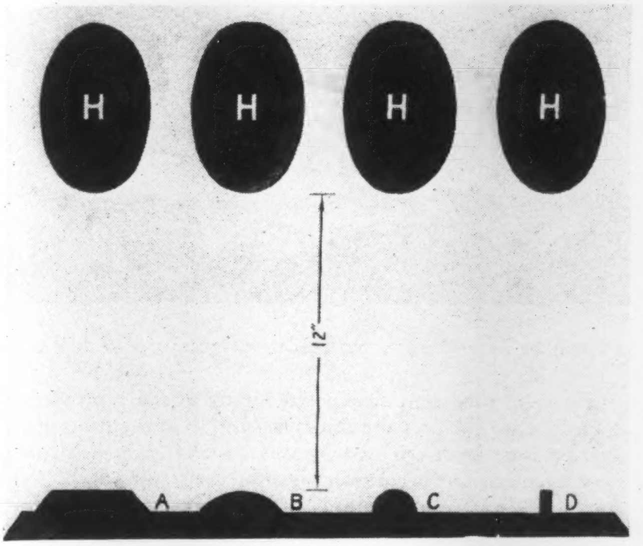


FIG. 1 THE TYPE (OR SHAPE) OF OBJECTS CAUSES DIFFERING DEGREES OF INJURY IN SAME ACCIDENT

braces, the feeling has been that this was a normal and expected part of the hazards of flying.

Two factors are contributing to this condition. One is that designers are accepting injury and fatality as a reasonable expectation in all crashes and have had no working figures on the number of accidents which are truly survivable. The other factor apparently is that engineers are not using, advantageously, the increasing knowledge on the strength of the human body. They are not stressing seats, belts, harness, or fastenings to utilize the fact that the human body can stand tremendous force—for brief intervals if given reasonable protection.

It is almost impossible for the mind to accept the fact that under ideal conditions a human being can withstand gravity increases exceeding 100 g and can be stopped from a velocity of 50 miles an hour within a distance of 6 inches—without injury. Yet well authenticated instances of such survivals have occurred. On the other hand, fatality can result in a 10 or 15-mile-an-hour accident where the momentum of the head and body is not checked during an abrupt deceleration of surrounding structure. Under these conditions, even though low velocities are involved, the impact forces can be exceedingly dangerous, especially if localized by hard objects. It is significant to note, in this regard, that according to National Safety Council statistics, 40 per cent of automobile *fatalities* in urban districts involved a speed of 20 mph or less—and 70 per cent were attributed to accidents in which the speed did not exceed 30 mph.

In order to emphasize the mechanics of injury caused by localization of pressure during brief or "impact" decelerations in low-velocity accidents, the arrangement in Fig. 1 is shown.

The object *H* represents a human head which has an approximate weight of ten pounds. It is supported over a group of objects having different contours marked *A*, *B*, *C*, and *D*. The distance between the head and the objects is 12 inches so that, if the head is allowed to fall, it will accelerate from the force of one gravity and reach a velocity of 8 fps when it strikes one of the objects below. From the point of view of simple physics the arrangement represents a 10-lb weight lifted one foot and having a potential energy of 10 ft-lb. When this weight falls from its height of one foot, it develops a kinetic energy of 10 ft-lb or 120 in-lb or 480 quarter-inch-pounds.

If it strikes a solid flat surface such as *A*, the skin and tissues over the skull compress and the skull deforms 5–6 mm so that the stopping distance of the head will be in the order of $\frac{1}{4}$ in. During the time and distance of this retardation—or deceleration—the force on the skull would be in the order of 480 quarter-inch-pounds, which would be distributed over an area approximating one square inch or $6\frac{1}{2}$ sq cm of area. Eight feet per second is above fast walking speed. Any of us who have walked slowly into a solid object in the dark know that painful bruises can be sustained from striking a solid object at full walking speed.

If the object struck is not flat but offers a convex surface as indicated by *B* and *C*, there is an important variation of the injury result due to increased localization of pressure. Instead of being distributed over an area of one square inch, the pressure may be localized to half this area—or about 3 sq cm. In this area the pressure will be twice 480 lb or 960 lb. According to experiments by Hyrtl, Messerer, and others who have studied the strength and elasticity of skulls, this pressure can be tolerated by the stronger bones of the average skull. All of us who have barged into *projecting* objects, even at lesser velocities, know however, that very painful damage of tissues is the sure result of such a localization of force and pressure.

The object indicated at *D* represents a steel projection solidly held. When the head falls on this object it meets a hard sharp object having an area of one square centimeter. The minimum average pressure would be highly localized during the quarter inch of stopping distance under these conditions and would be 3 times 960 lb or close to 2800 lb, or 1271 kg per sq cm. This is considered to be more than sufficient to cause a puncture fracture of the average skull.

The head is not a sledge hammer in the sense of true solidity. Yet, granting variations in the type of blow it can deliver due to complications of its structure, the fact remains that its mass and energy are such as to make possible formidable blows under relatively simply conditions. A fall of a few feet which terminates with the head striking a rock or a curbstone often is sufficient to cause fatal results.

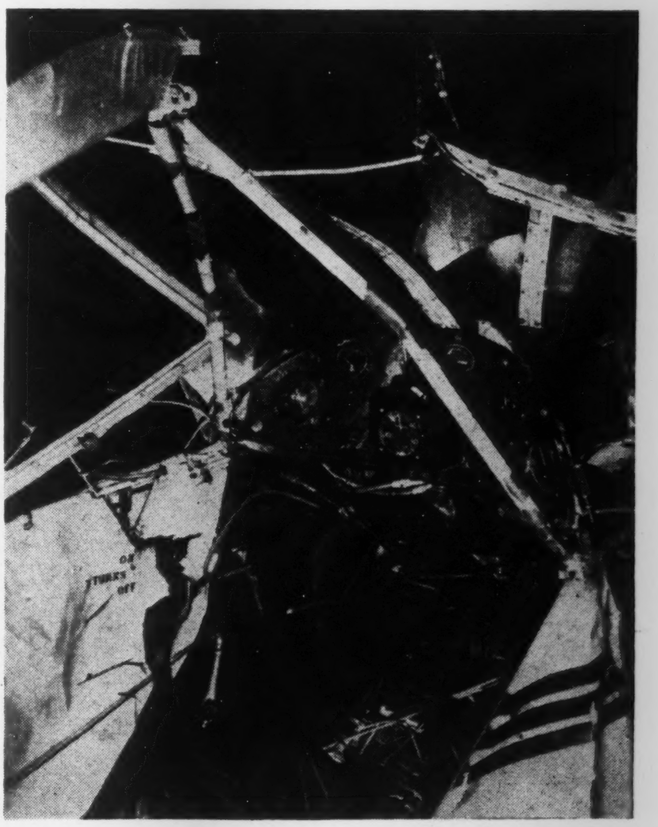


FIG. 2 DENTED DIAGONAL BRACE WHICH CAUSED FATAL HEAD INJURY IN AIRCRAFT ACCIDENT OF MODERATE FORCE

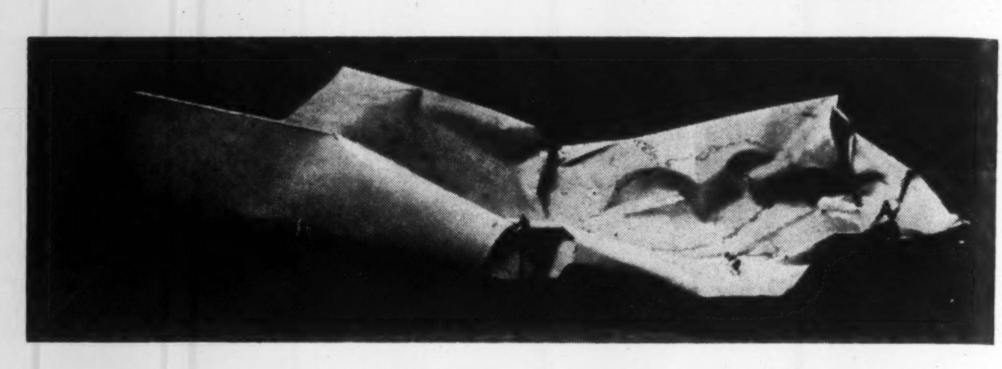


FIG. 4 SHEET-METAL VENTILATOR CRUSHED AS RESULT OF NONFATAL SUICIDE JUMP OF 145 FEET

Where tube clusters, exposed braces, projecting switch handles, and hard control knobs are within range of the head in aircraft accidents, serious results can scarcely be avoided.

As would be expected from a mechanical point of view, it is not unusual to find fatal head injuries in aircraft accidents without any other mark of material injury on the body.

Until very recently, causes of injury in accidents were not studied or recorded, but there can be no doubt that results similar to those in Fig. 2 have been duplicated many times.

It will be noted that one diagonal brace in this illustration shows a compression result; the other indicates that it has been hit and dented by a heavy object. The passenger in the rear seat in this crash walked away from the accident but the pilot in this front seat sustained a depressed frontal fracture of the skull. He was instantly killed. The passenger in the rear seat was exposed to the same crash force but because of a safer environment he missed striking a lethal object with his head. Had he struck a solid object, such as the back of the front seat, the same mechanical results as those in the front seat would have been registered and the crash would have terminated in a double fatality.

There is no intention of indicting this one type of plane for many makes of planes have braces in this or other dangerous positions. In accident results of this kind it seems reasonable however to ask the question "was this fatality caused by pilot error—or by an error in design?"

In an accident where the head or any other part of the body is thrown forward against exposed tubing or sharp projections which localize the pressure injury is sure. On the other hand, when pressure is distributed by surfaces that can yield under heavy force extraordinary safety is often the result.

FIG. 3 INSTRUMENT PANEL DAMAGED BY PILOT'S HEAD. DISTRIBUTION OF PRESSURE PREVENTED SKULL FRACTURE

In Fig. 3 we see an example of such pressure distribution. This was a severe accident. The pilot's head struck and dented the instrument panel as shown. Yield of structure and distribution of pressure prevented a skull fracture. His only important injury was a three-inch laceration on the forehead. Witnesses state that he was not knocked out by this blow and got out of the plane without assistance.

In the accidents illustrated by Figs. 2 and 3, and in many others, the marked difference between the injury potentials of various structures is demonstrated. Obviously a transverse tubular brace concealed under the dented instrument panel in Fig. 3 would have given a high probability of fatal injury in a blow of this magnitude. In an accident having a strong downward component of force serious results would have been certain if the heavy throttle knob had been struck.

Crash padding of instrument panels, seat backs, and solid structure is of some value in modifying impact injuries but it is at best a makeshift protection against built-in hazards. Under severe conditions little is gained by shielding solid objects with sponge rubber a few inches deep. The obstruction remains, and although the head may be spared some degre of injury, the momentum and pivoting action of the torso on the seat belt after the head has been stopped, sets up the danger of spinal injury. Fracture of the cervical or lumbar spine—or both—from this cause is not an unusual result even in moderate accidents. A number of proposals have been made for modifying dangers inherent to the present placement and construction of the instrument panel, and it is believed that practical answers will be found.

The vulnerability of the body to high localization of force and stress is in striking contrast to the degree of protection afforded by distribution of pressure. Escape without serious injuries in accidents of apparently formidable force are often attributed to miraculous instead of mechanical causes.

An amazing instance of survival through pressure distribution is indicated in Fig. 4. This metal structure was crushed as shown when struck by a person after a suicide jump of 145 ft. The survivor of the fall sustained fractures of each arm where exposed to stress through extending beyond the main supporting zone. One foot struck the tiling with considerable impact, but beyond these fractures of the extremities, no other material injuries were found. The individual involved sat up immediately and asked to be taken back to the room on the 17th floor from which the attempted suicide jump was made. In cases of this kind interest lies in the reason why no internal injuries resulted and why no apparent loss of consciousness occurred under force conditions approximating 100 gravities.

Fifteen falls from heights of 50 to 150 ft onto solid ground and various mechanical structures have been studied. The force in some of these accidents approximated 200 gravities without serious results. Explanation of these seeming im-

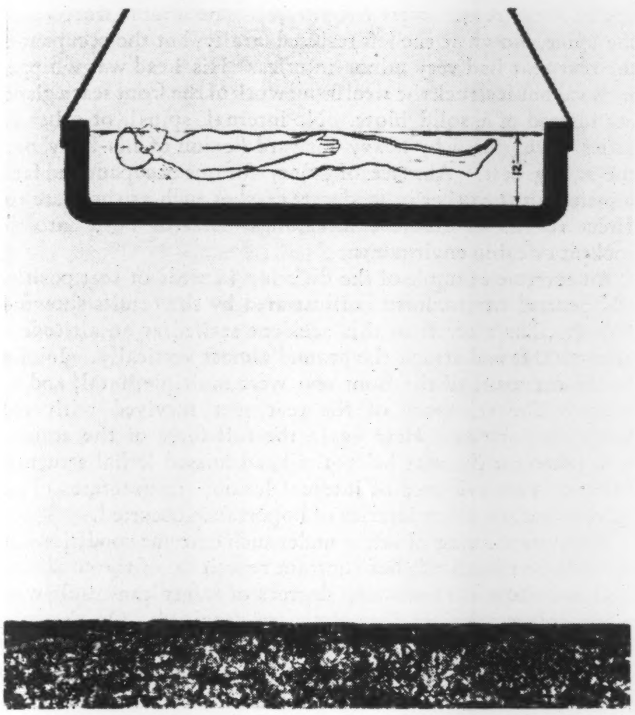


FIG. 5 HAZARDS OF SUDDEN VELOCITY CHANGE ARE NULLIFIED BY DISTRIBUTION AND COMPENSATION OF FLUID PRESSURES WHEN TANK IS STOPPED ABRUPTLY AFTER DROP OF 100 FEET

possibilities leads again to straight mechanics which, by definition, is that part of the physical sciences that treats of the action of forces on material bodies.

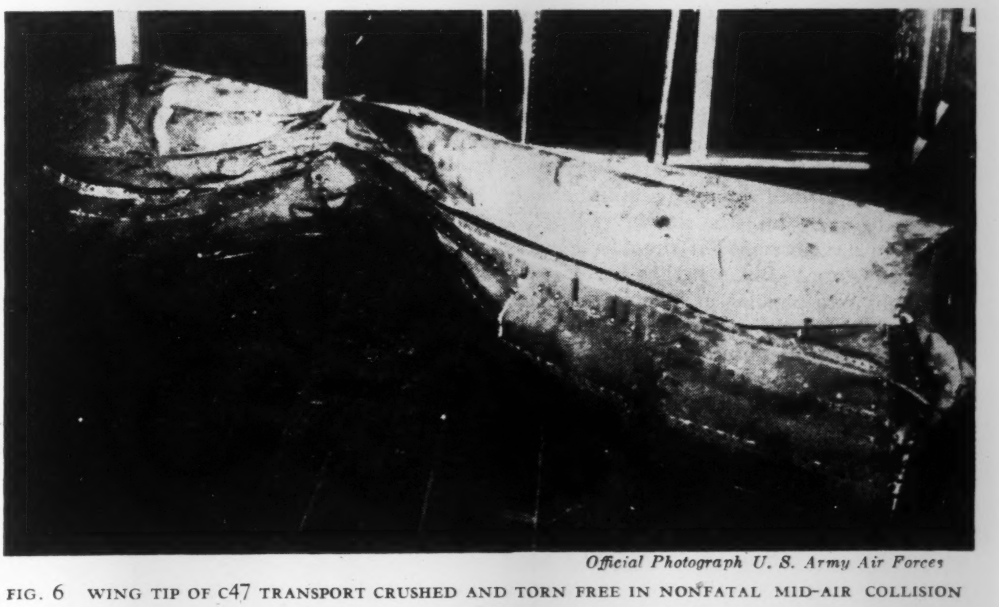
In order to emphasize the principles of pressure compensation and pressure distribution to which these survivals are attributed, we can consider the arrangement indicated in Fig. 5. "A" represents a heavy steel tank filled with water in which a man is floating submerged but near the surface. If we cap this tank effectively and pump helium and oxygen in to create a pressure of 100 psi, the man would find himself substantially surrounded by the conditions of a deep-sea diver at a depth of about 200 ft. If this pressure were applied and reduced gradually no bodily harm would be expected, for the pressure between the man and the water would have been compensated during the pressure period.

Bearing in mind the principles of the hydraulic ram, there is another way fluid pressure in the tank can be increased and compensated, namely, by setting the fluid mass in motion and then stopping it abruptly. If, therefore, we drop this tank a few feet and stop it in a few inches in the sand indicated below, the gravity increase caused by the stopping action will cause an increased fluid pressure on the bottom and sides of the tank and on the submerged parts of the man's body. But as the submerged man is himself a semifluid semielastic mass, having a specific gravity very close to that of the water, the effects of gravity increase on his body will be proportionately about the same as that of the water and relative pressures between the man and the water, from an injury point of view, will be canceled out by pressure balance or compensation.

If the tank were hoisted 100 ft and dropped, the pressure effect between the water and the man would be increased a little more than 100 times during one foot of uniform deceleration. This increase of gage pressure would amount to about 44 psi at the bottom of the tank. Six inches from the surface of the water the increase of pressure would amount to only about 22 psi and lesser increases of pressure would be registered, of course, closer to the surface. There would be substantially no movement of the man in the fluid medium and none of the injuries expected of a 100-ft fall—or of a gravity increase to 100 g—would occur. There would be no lacerations, contusions, or fractures, because there would be no stress—no bending, twisting, shearing, or tension. Pressure effects would be almost perfectly balanced. The mechanical hazards of injury would virtually cease to exist.

Fortunately, conditions do not have to be ideal to bring this important protective agency into action. Any broad structural surface which will yield slightly can distribute pressure and give amazing results. Stunt drivers who smash cars into stone walls to thrill crowds use this effect of pressure distribution. They jump to the rear just before the crash and brace themselves against the back of the front seat. Crew members of bombers facing the necessity of a crash-landing or a landing in water now brace themselves against flat surfaces and shoulder harness provided for pilots relates the body to aircraft structure to utilize the effects of deceleration and pressure distribution.

The strength of the body even where only limited portions are supported during a high rate of acceleration is illustrated by the results in Fig. 6. In this accident a man who had jumped from a preceding plane during parachute practice, was struck in mid-air by the wing tip of a C47 transport plane. The impact speed was estimated at 70–80 mph, and the force of the blow dented the wing-tip structure as shown, tearing it from its fastenings as can be noted by the condition of the rivet holes at the inboard end of the section. The main force of this blow was taken on the right shoulder and chest and fractures were sustained in these areas probably before any material distribution of pressure took place. The man survived the force of this extreme accident with limited disabilities. He is back at work in the Service. The aircraft, incidentally, was landed with only slight damage to the landing gear.



Official Photograph U. S. Army Air Forces

FIG. 6 WING TIP OF C47 TRANSPORT CRUSHED AND TORN FREE IN NONFATAL MID-AIR COLLISION WITH MAN DURING PARACHUTE PRACTICE

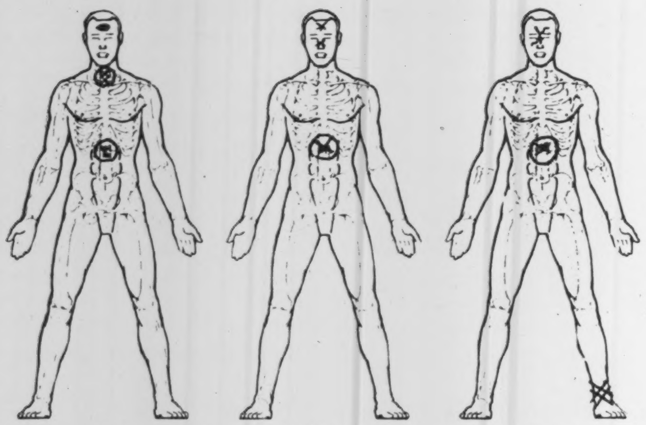


FIG. 7 COMBINATION OF HEAD INJURIES AND SPINAL INJURIES CAUSED BY ACTION OF SEAT BELT AND PLACEMENT OF INSTRUMENT PANEL

The principal physiological interest of this accident hinges on the fact that no intra-abdominal injuries were sustained as a result of the force, and that the skeletal articulations of the neck and lower extremities withstood the severe strains imposed by lack of support for the head and legs. Force distributions, somewhat similar to those occurring in this accident, are set up in serious crashes by the action of shoulder harness and safety belt. Often, in accidents giving every expectation of fatality, survival without serious injury results from the effectiveness of these safety measures.

Between the extremes of full localization of pressure with sure injury, and reasonable distribution with high degrees of protection is a vast middle ground of hazard due to various stresses imposed on the body in the high decelerations often imposed by aircraft accidents.

It is in this middle ground that practical measures can be taken to give increased protection and to enhance safety. And it is from the middle ground of moderately severe crashes that the mechanical causes of injury and survival can be observed.

Unfortunately, in the present arrangement of cockpits and cabins the true possibilities of survival are seldom seen. Except where shoulder harness is worn, the velocity and momentum of the head remains unchecked until it crashes into forward structure. As a result, serious or fatal lesions of the head are registered with mechanical certainty; there is small room for wonder that head injuries in survivable accidents exceed all others in frequency and importance.

These serious hazards for the head are often reflected in complementary injuries of the spine such as those indicated in Fig. 7 and the combination of a crushed head and broken neck commonly leads to judgment that the accident itself—instead of an unfortunate cockpit arrangement—justified the severe results.

Actually, the injuries shown in Fig. 7 would not have occurred if shoulder harness had been worn. But whether harness can be brought into popular use among civilians is problematical. It is generally assumed that it will be difficult to sell the public on the safety of flying and, at the same time, convince them that the hazards are such as to justify the use of cumbersome restraining gear.

A more practical answer to the severe injuries caused by the instrument panel would be to space the panel slightly beyond range of the head. With a better arrangement of this one feature, injury of the face and head and spinal injuries such as those shown in Fig. 7 would be rare. The crashes which caused these results were not severe. The double fractures of the spine shown at the left resulted fatally, but the occupant of the rear seat had very minor injuries. His head was whipped forward but it struck the steel framework of the front seat a glancing instead of a solid blow. No internal, spinal, or other injuries were caused by heavy forward flexion of his body over the safety belt. Absence of injury for one occupant and fatal injuries for the other in moderate crashes such as these are the direct results of different mechanical hazards built into the cockpit or cabin environment.

An extreme example of the differing hazards of seat position and general environment is illustrated by the results shown in Fig. 8. The aircraft in this accident stalled at an altitude of about 100 ft and struck the ground almost vertically. Injuries to the occupant of the front seat were multiple, fatal, and extreme. The occupant of the rear seat survived with very moderate injuries. Here again the full force of the accident was taken on the seat belt; the head missed lethal structure; there was no evidence of internal lesion; no fractures of the extremities, or other injuries of importance occurred.

Absolute sureness of safety under such extreme conditions can scarcely be visualized, but constant repetition of the conditions outlined show that amazing degrees of safety can result when reasonable conditions for safety are provided. On the other hand, there is a constancy of injury when structure is so placed as to give sure mechanical results.

A large expansion in use of aircraft by civilians will require more than mere concessions toward safety. It will require deliberate planning of safety with acknowledgment that this one factor—more than speed, efficiency, or cost—will govern the extent of future developments. Heavy and unnecessary penalties will be paid by the public—and the aircraft industry—until safety is considered foremost among design factors in aircraft for broad public use.

Fortunately, human structure shows an amazingly high tolerance of force where pressure distributions are reasonable. Its ability to withstand extreme forward flexion, and the severe snubbing action of the seat belt, alone opens new horizons of safety thought.

Repeated evidence on causes of injury and survival in aircraft accidents indicates that a large increase of safety can result from simple and practical measures. In spin-proof planes of the future, with stronger seats and safety belts, better placement of instrument panel and improved cabin arrangements, degrees of safety beyond reach a few years ago can be achieved by engineers who recognize and exploit essential biomechanical facts.

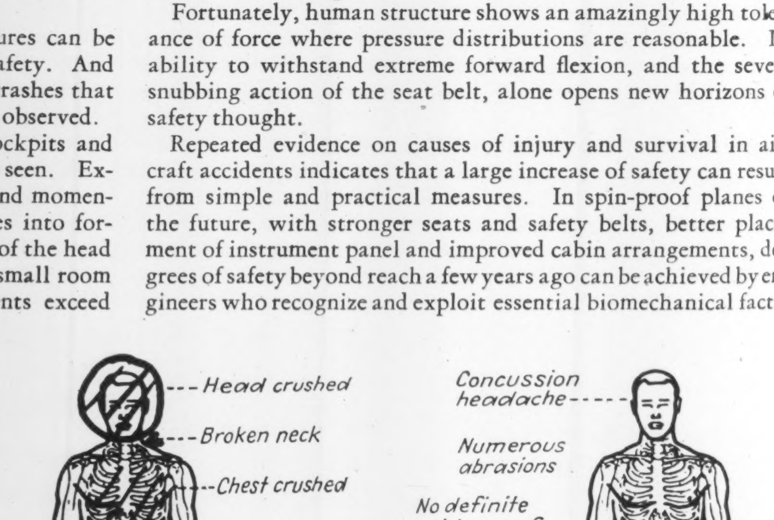


FIG. 8 DIFFERING DEGREES OF INJURY CAUSED BY HAZARDS OF DIFFERENT ENVIRONMENTS IN THE SAME ACCIDENT

THE MANPOWER PROBLEM[1]

By CHARLES A. MYERS

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

At a time when many people thought the crisis in manpower had passed, President Roosevelt proposed on Jan. 11, 1944, a National Service Law as one part of a five-point program to speed the winning of the war. In the weeks following the President's proposal, no serious consideration was given to it by Congress, possibly for political reasons. Is National Service really necessary to meet the manpower problem at this particular time? What steps have been taken, and what more can be done, short of such a drastic proposal?

A host of articles have appeared in various trade journals about the manpower question, but only one significant book has been published. "Manpower for Victory: Total Mobilization for Total War,"[2] by John J. Corson, is written for the "average citizen" and it attempts to outline the manpower problem in terms of where the manpower is required, where it has come from, where additional manpower has to be found, and what steps are necessary to get manpower where it is needed. A final chapter describes in broad outline some of the problems that will arise when demobilization day comes. Mr. Corson speaks from intimate acquaintance with these problems at the federal-government level, since he was formerly director of the United States Employment Service, the keystone of the War Manpower Commission organization. The book is not an official document, but in a foreword, Paul V. McNutt, chairman of the War Manpower Commission, compliments the "fundamental soundness and professional integrity of the book."

MANPOWER RESERVES IN 1943

When the book was written, a serious manpower crisis was anticipated by January, 1944, when approximately 1.7 million more workers and servicemen would be needed in the labor force and armed forces than in January, 1943. This figure underestimates the problem, for nearly another million had to be transferred from "less essential" industries to war production. Considerable transfers had taken place before 1943, as workers were attracted from peacetime pursuits to higher-paid war work. The pool of unemployed was also exhausted. There then remained two reserves which had been inadequately tapped: (1) Those not working, principally women and younger people, who could be brought into the labor force; and (2) Negroes, aliens, and other minority groups whom many employers were reluctant to hire. Besides those to be attracted from less essential industries, there was a third "reserve" of employed workers who could be utilized more effectively.

How successfully did the War Manpower Commission meet the problem of growing labor shortages? It came into the picture late—five months after Pearl Harbor—and up to December, 1942, it did very little but issue "directives" to other government agencies. Its status and powers were not clarified until the executive order of Dec. 5, 1942, transferred the Selective Service System to the W.M.C. and gave the latter increased authority. The following months more vigorous steps were taken.

First, increasing pressure was brought on the procurement agencies of the Army and Navy, and on the War Production Board, to place new contracts in areas of labor surplus, rather than accentuating labor shortages by continuing to place additional contracts in such cities as Los Angeles, Seattle, Detroit, Buffalo, and Hartford. Between April and September, 1943, the labor surplus (Group IV) areas received 12 per cent of all war contracts as compared to only 9 per cent from September, 1939, to March, 1943. This shift has been estimated at more than half a billion dollars worth of war contracts. While it helped to prevent labor-shortage areas from becoming worse, the action came too late to be of major significance. A cardinal error in our war-production program before and after Pearl Harbor was the failure on the part of the procurement agencies to consider labor supply in the placement of contracts.

The uneven pattern of labor shortages in the country forced the W.M.C. to develop the second of its major programs during 1943—local stabilization plans and controlled hiring. Begun in Baltimore late in 1942, these plans at first were rather mild attempts to limit labor turnover and pirating by voluntary agreement of all employers in an area. In some areas, such as Louisville, Ky., they included controls over the hiring and transfer of workers in certain "critical occupations."

Adoption of these stabilization programs was stimulated by the executive order of April 8, 1943, and by the W.M.C.'s order of April 17, which prohibited the transfer of workers in essential activities to new jobs solely for reasons of higher pay. "Certificates of availability" were to be given to workers in essential activities under certain conditions, such as layoff, discharge, "undue personal hardship," failure of the employer to use their highest skill, or to employ them full time. Workers still left war jobs for other war jobs in 1943, but the number did not continue to rise. In fact, labor turnover in all manufacturing in November, 1943 (the last figure available), was lower than in November, 1942.

REPLACEMENT SCHEDULES

Third, haphazard military withdrawals were largely stopped by the development of the "manning table" and "replacement schedule" program. The latter was more useful to most firms, because it enabled them to get Selective Service approval of a definite schedule for the drafting of their eligible male employees. Voluntary enlistments and drafting of key workers without advance warning had earlier created serious personnel problems for many firms.

Other steps taken by the War Manpower Commission during 1943 were less important. The 48-hour work week was ordered in all acute labor shortage (Group I) areas, and was also extended to a number of labor "stringency" (Group II) areas. The object was to release workers for other industries, or at least to reduce the number of new hires as replacements were necessary. Actually, the results were not spectacular, as many firms were already on a 46 or 48-hour week. Another development was the list of "nondeferable" activities and occupations, which was intended to force workers in those activities and occupations to transfer to war jobs under threat of being drafted. This got mixed up with the father-draft question and amounted to very little.

Reviewing the developments into 1943, Mr. Corson concludes: "Our experience with voluntary methods, and all the experience of other nations, leads to the conclusion that the necessary labor will not turn up without the use of various pressures and compulsions." He suggests that the federal government by legislation must have the power to:

"1 Register and then assign all adult men and women to war jobs where they are needed;

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[1] One of a series of reviews of current economic literature affecting engineering, prepared by members of the department of economics and social science, Massachusetts Institute of Technology, at the request of the Management Division of The American Society of Mechanical Engineers. Opinions expressed are those of the reviewer.

[2] Farrar and Rinehart, Inc., 1943, New York, N. Y., 299 pp.

2 Transfer workers from one job to another or from one city to another as the war effort requires."

This is, of course, the much-debated National Service proposal. It got nowhere in 1943, although further steps in the direction of greater controls were taken toward the end of the year.

THE WEST COAST PLAN

In the critical labor-shortage areas on the West Coast, a plan was developed to provide (1) production urgency committees which listed all firms in the area according to the "urgency" of their product in the war program, and (2) manpower priorities committees, which assigned priority ratings to firms according to (*a*) their production urgency, (*b*) the extent to which delays are attributable to manpower factors, (*c*) and the extent to which manpower needs could be met by better utilization of manpower. "Employment ceilings" were also established, to prevent excessive labor hiring and hoarding in some industries. Finally, all hiring of workers in critical occupations was channeled through the U. S. Employment Service, which made referrals according to "manpower priorities."

This program, described and proposed in the Baruch Report of Aug. 19, 1943, became the pattern for similar programs in such cities as Akron, Detroit, and Hartford. By February, 1944, field officials of the War Manpower Commission had been instructed to use any or all of these devices in rationing and allocating labor in particular areas. Meanwhile local stabilization plans continued—some of them notable for outstanding community efforts to lick the manpower problem, as in Dayton.

War production is now beginning to level off, and there is a growing impression that the worst manpower problems are over. It is true that total munitions employment will probably not expand much between January and July, 1944, but in particular industries, such as landing craft, aircraft, ship repair, radio, and heavy trucks, more workers are needed. Cutbacks are occurring in ammunitions and small arms, but not enough to offset the afore-mentioned needs. In certain other vital industries, such as railroad transportation, ball bearings, foundries, coal, and meat packing, the labor shortage is still serious. On top of all this, the armed forces require a net increase of 800,000 in their strength by July 1, and will have to induct 1,400,000 to compensate for those discharged or lost.

So the manpower crisis has not passed, principally because the armed forces will make further inroads on the civilian labor force. Is National Service then necessary as a means of meeting manpower needs before summer? On the realistic assumption that registration and assignment of millions of workers is a task requiring better organization of the labor market than we have now, the answer is, No. The job probably could not be completed before the critical needs had passed. National Service possibly may be justified on other grounds, such as "equal, sacrifice" (though there are arguments on the other side) but not as a measure that would solve our labor shortages within the next six months.

The best answer to these shortages lies in an intensification of the community programs already developed in such areas as the West Coast, Buffalo, and Dayton, Ohio. The problem is one of local responsibility; Washington cannot solve it by edicts and executive orders. Even more, the problem must be attacked with increased vigor and intelligence at the individual plant level. Better utilization of employed manpower is necessary, and every company must reassess its personnel policies in the light of 1944 realities.

An outstanding personnel man, Lawrence A. Appley,[3] now executive director and deputy chairman of the War Manpower Commission, made the following suggestions to a meeting of the American Management Association in Chicago, February 9:

> Have a specific and carefully worked out program for your plant or company. . . . Such a program is nothing more nor less than a comprehensive wartime personnel program and it should provide for careful handling of all activities from recruitment, through orientation, training, wage administration, labor relations, housing, and transportation facilities, community facilities, etc. . . . . Do not forget that during wartime there are many government agencies and services available to help you. . . .
>
> Remember that your personnel program and manpower activities are no longer a matter of your own business. You operate in a glass house because the community is vitally interested in and very critical of the influences that your manpower practices have upon other activities in the community.

Does an Engineer Need His Profession?

(*Continued from page 253*)

of planning, construction, production, operation, or selling may offer little natural outlet for social idealism or influence. The less he finds this outlet in the first mile of individual effort, the more he needs it in the second mile of his professional associations.

Let us risk a look into the next 50 years, which our present student engineers are to share in shaping. The climax of man's effort to subdue nature, to shift labor from muscles to machines, to make material abundance available to all, and to extend a high civilization into the backward areas of the world may well fall within their lifetime. After that, perhaps human interest may shift from work to leisure, from production to enjoyment, from economic progress to culture and from industry to art. Who knows? In the meantime, however, it seems inevitable that industry will be extended on world-wide lines, production will grow more scientific, research will expand, and engineers will multiply accordingly.

Engineers will find their way into every field where science needs to be practically applied, cost counted, returns predicted, and work organized systematically. They will be called upon to share the control of disease with physicians, the control of finance with bankers, the bearing of risks with underwriters, the organizing of distribution with merchants and purchasing agents, the supplying of food with packers and purveyors, the raising of food with farmers, and the operation of the home with housewives. In few of these new fields, if any, will engineers be self-sufficient; to be useful they must be teamworkers; and they must be prepared to deal with "men and their ways," no less than "things and their forces."

The engineering profession, it seems equally evident, will bear much heavier responsibilities in civic and economic affairs. It cannot afford to become either a narrow caste of highly skilled technicians or a free-for-all alumni association of engineering graduates. It will probably never be able to define its boundaries precisely, nor become exclusively a legal caste, nor fix a uniform code of educational qualifications. Its leaders will receive higher rewards and wider acclaim. The rank and file will probably multiply more rapidly than the elite, and rise in the economic scale to only a moderate degree.

The engineer's job will be so varied, and will change so fast, and his tools will so increase in variety and refinement with the advance of science, that no engineer can hope to get a once-and-for-all education in advance.

We should cease to think of education as a juvenile episode. We should expect to re-educate engineers either continuously or at intervals throughout their active careers. Once the needed means of after-college education are provided in ample degree the engineering colleges could broaden the scientific and humanistic bases of their curricula, cut down on early specialization, relieve overcrowded schedules, inspire independent work, and show the world the best balanced and best integrated of all modern disciplines.

Millions of individual unrelated efforts will not add up to the future that invites our profession. This is no time for engineers to wrap themselves in the mantle of isolation; let us get together and be about our common business.

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[3] An article by Mr. Appley, "Manpower Utilization in the United States," appeared in the December, 1943, issue of MECHANICAL ENGINEERING, pp. 855–861.

COMMENTS ON PAPERS

Including Letters From Readers on Miscellaneous Subjects

Conservation of Resources

Comment by K. H. J. Clarke[1]

This paper[2] is of great interest, since nonferrous metal-conservation measures in Canada, because of general similarities, have been introduced along similar and parallel lines to those adopted in the United States. Where control and conservation measures differ, they do so because of fundamental supply differences. As a particular example, the early establishment of standardized cast-bronze specifications in Canada was based upon a more rapidly diminishing supply of tin-bearing grades of brass and bronze scrap than was being experienced in the United States.

The conservation of tin became particularly important following December 7, 1941, when the Japanese struck at Pearl Harbor, and the biggest part of the United Nations supply was abruptly cut off.

Substitutions and specification revisions as related to tin, had their most important impacts on solder, babbitt, tin plate, cast and wrought bronzes, and collapsible tubes. Directly or indirectly the specification changes influenced almost all civilian and military applications. In Canada the diversity and breadth of the revision of tin-bearing specifications alone presented a very large task indeed.

Considerable quantities of tin are regularly consumed in solder. Prior to and during the early part of the war, the general run of specifications was from 40 to 50 per cent tin; remainder lead. An order limiting tin in solder to a maximum of 38 per cent, except by special permission, was instituted immediately following Pearl Harbor. Since that time improved techniques have progressively lowered the tin content until, for most general applications, the specifications vary between 15 and 30 per cent tin content with or without the addition of elements other than lead to decrease melting temperatures or for other reasons.

In addition very considerable advances have been made in the use of silver-lead solders of the $2^{1}/_{2}$ per cent silver, $97^{1}/_{2}$ per cent lead variety. Some of these solders contain small amounts of tin and copper. This type of solder has been extremely successful particularly in machine-soldering operations and especially in the canmaking industry, where it is used almost exclusively at the present time for the soldering of side seams.

It has been necessary to develop suitable fluxes concurrently with substitute solders. The success attained by flux manufacturers has contributed greatly to the development of the tin-free and low-tin solders. There are, of course, still a few special cases, in relatively small quantities, such as the soldering of radio, radar, and fire-control apparatus for the armed services for which higher-tin-content solders are released.

There has also been a very considerable increase in the use of alternative types of joining, such as silver brazing, welding, and mechanical joints.

In regard to babbitt: Prior to Pearl Harbor a large percentage of babbitt manufactured and consumed in Canada contained from 85 to 92 per cent tin; remainder antimony and copper. Most babbitts produced now contain a maximum of 15 per cent tin. In addition there is a very considerable production of arsenical lead-base babbitts which contain not more than 1 per cent tin. Except for naval marine bearings and for one or two exceptionally hard services, such as large primary crushers in the mining industry, specifications are held to the 15 per cent tin maximum.

A considerable amount of study and work has been done in prolonging the life of babbitt by improving babbitt techniques, particularly in the preparation of the bearings, such as cleaning, fluxing, and the pouring and chilling processes.

It has also been proved by scientific tests that for bonded babbitts thinner deposits will give improved life.

There has been excellent co-operation on the part of industry in the careful reclamation of high-tin babbitts as they are removed from use so that they can be saved and re-used for more essential applications.

In regard to cast bronzes, specifications such as 88 copper, 10 tin, 2 zinc; 88 copper, 5 tin, 5 nickel, 2 zinc; and 90 copper, 10 tin were predominantly specified for the armed services during the pre-Pearl Harbor period. These specifications were thoroughly reviewed and, in order not only to conserve virgin tin but also more advantageously to use the tin content of scrap red brasses available in Canada at the time, it was decided to standardize on a series of tin-bearing ingots to which specifications could be uniformly revised. Identification colors and symbols designate these standard ingots which are now widely and favorably known in Canada.

"A" ingot, which is used for castings for steam fittings to be used in installations having over 150 psi pressure and a maximum temperature of 500 F, was established at 5 to 6 per cent tin, 1.25 to 1.75 per cent lead, 4 to 5 per cent zinc, 0.75 and 1.25 per cent nickel; remainder copper.

"B" ingot, which is used for castings for steam fittings to be used in installations having a pressure range from 75 to 150 psi and a temperature not exceeding 370 F, was established at the standard 85 per cent copper, 5 per cent zinc, 5 per cent lead, 5 per cent tin range.

"C" ingot, which is used for castings for steam fittings to be used in installations having 75 psi or less, or for castings, for industrial or domestic steam heating has a range from 2.5 to 3.5 per cent tin, 6.5 to 7.5 per cent lead, 8 to 10 per cent zinc, balance copper.

"D" ingot, which is used for castings for general use as bearings and bushings, contains 4.5 to 5.5 per cent tin, 8 to 10 per cent lead, 3.5 to 4.5 per cent zinc, 0.75 and 1.25 per cent nickel; remainder copper.

"E" ingot, which is used for castings for all plumbing supplies, hot-water heating, air and gas fittings, contains 0.75 to 1.25 per cent tin, 7 to 9 per cent lead, 12 to 15 per cent zinc; remainder copper.

"F" ingot, which is used for castings for general hardware and general structural purposes, and which was designed to consume considerable quantities of available yellow-brass scrap, contains not more than 1.50 per cent tin, 2.5 to 3.5 per cent lead, 28 to 32 per cent zinc, balance copper.

A, B, C, D, E, F ingots are identified, respectively, by the colors, red, yellow, green, blue, black, and white and must be so marked by ingot makers.

In addition to these standard tin-bearing alloys, many of the specifications were converted to tin-free manganese bronze, any of the several silicon bronzes available, or to aluminum bronze, where their specific physical properties satisfactorily met the conditions that were imposed.

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[1] Office of Metals Controller, Department of Munitions and Supply, Ottawa, Canada.

[2] "The Continuing Need for the Conservation of Resources," by Howard Coonley, Mechanical Engineering, November, 1943, pp. 785–788.

Many advantages in addition to tin conservation were effected by standard alloys, particularly in the field of simplification of ingot and castings manufacture.

The most important wrought bronze, containing tin, for which substitutions were generally found, was the 1 per cent tin naval brass. Manganese bronze, silicon bronze, 85/15, and aluminum bronze were all substituted where their particular properties best met the conditions to be encountered.

One of the most important fields of study, and one which probably hit home to the individual more than any other, was that of tin plate. Before Pearl Harbor the standard material for the manufacture of tin-plate containers was a tin-coated steel sheet containing a minimum of 1.5 lb of tin per base box of approximately 100 lb. This was reduced to a maximum of 1.25 lb, except for a restricted list of highly acidic food packs.

The development of electrolytic tin plate, in which this coating is reduced to 0.5 lb, has also been an interesting development of the last 2 years, and portends to be an important tin saver, although the supply from the United States has not been sufficient to allow of a very large export to Canada as yet. Electrolytic tin plate is not at the present time manufactured in Canada.

Many civilian items, such as baking powder, coffee, tea and shoe polish, were switched out of metal entirely to containers of paper board or glass. Many foodstuffs which could be packed dry or in other containers were eliminated from metal.

Another interesting item was collapsible tubes which before Pearl Harbor were almost all made of pure tin. Faced with virtually an immediate cutoff from tin, the collapsible-tube manufacturers showed considerable ingenuity in developing silver-lead compositions containing less than $1^1/_2$ per cent tin. These compositions have been very successful and the demand still taxes the capacities of the collapsible-tube plants. Pure tin tubes have disappeared except for use for an occasional medicinal product.

Many other conservation fields have been studied and measures implemented during the last 2 years. An outstanding example is the field of electroplated steel substitutions for solid nonferrous materials, and the use of various electrodeposits for other specified electrodeposits which have been in a more critical supply. Generally speaking, the supply situation has been such that they have been selectively substituted for each other in accordance with a list headed by tin and followed progressively by cadmium, nickel, copper, zinc, and chromium.

Other useful conservation techniques, such as brazing, silver-soldering, bronze-welding, and salvage-welding of all types, have been encouraged and have been specifically recommended from time to time.

Technical advisory committees, dealing with babbitt, solder; electroplating and metal finishing; welding, brazing, and hard-surfacing; and nonferrous castings and wrought materials, the membership of which consists of representatives of the armed forces, inspection agencies, industry, and the Office of the Metals Controller, have been very helpful in the implementation of conservation matters dealing with those subjects during the very trying period when shortages were most severe.

COMMENT BY WILLIAM A. DUNCAN[3]

In October, 1942, Mr. Harry Carmichael, Co-Ordinator of Production, Department of Munitions and Supply, Ottawa, announced his conservation program. It immediately interested us, for two reasons: (1) Because the welding industry is tied in so closely with conservation in industry that we felt that we could make a substantial contribution in this direction to Canada's war production; (2) Mr. Carmichael had appealed to the Scot in us.

Mr. Carmichael stated at that time that Canada faced a shortage in critical materials, manpower, and machine tools and urged the co-operation of industry in alleviating this situation.

The welding industry has made substantial contributions in this direction, but it should be understood that all accomplishments in this field have been made by war industries themselves and our part, as suppliers of welding and cutting gases and equipment, has consisted only of technical and practical advice and assistance.

Innumerable examples of conservation of critical materials by welding could be given but we have time to mention only a few typical jobs. One of the most urgent war requirements was armored vehicles of all kinds. Welding procedures were established for bulletproof plate for scout cars, after a great deal of painstaking development. The introduction of automatic welding greatly accelerated production, for one automatic electric-welding head will do as much welding as ten to twelve manual arc-welding operators.

The original welding rod used for this application, for both manual and automatic welding, had one drawback. It was an austenitic rod containing high percentages of chromium and nickel, both critical materials. Further development, with the closest co-operation of the manufacturers of these vehicles, finally resulted in a ferritic rod for automatic electric welding. This met all physical requirements and passed the ballistic tests of the Inspection Board of the United Kingdom and Canada. It has resulted in an estimated annual saving of 81,000 man-hours and 25,000 lb of critical alloys (mostly nickel and chromium).

The greatly accelerated war industry in Canada required ever-increasing quantities of bronze welding rods for production, maintenance, and repair of machinery and equipment. Practically all modern bronze welding rods contained about 1 per cent of tin, a most critical material. At the urgent request of the Metals Controller, the welding industry developed a substitute bronze rod containing no tin whatever and thereby saved approximately 8750 lb of tin annually.

In regard to the conservation of manpower, Mr. L. E. Carr, Technical Director, British Ministry of Supply, Washington, D. C., has emphasized how the welding of armored vehicles and tanks has greatly reduced the man-hours per unit and has at the same time produced a safer and more successful vehicle. The introduction of automatic welding into this field has effected still further manpower savings and has correspondingly increased production.

Another highly important development by the welding industry is the increased use of automatic welding in shipbuilding. Because of the need for speed in shipbuilding and for large amounts of welding of all kinds, and because of the difficulty of obtaining a sufficient number of qualified manual arc welders, the introduction of automatic welding was a godsend. It is not exaggerating to say that the record established in high production in the shipbuilding program in America would not have been possible were it not for this process. This can readily be visualized when we consider that a single automatic welding unit in a shipyard, operated by only two men (operator and helper) has welded more than 600 linear ft in a day, a job that would normally require 10 to 14 men for manual arc welding.

It would be impossible to estimate the man-hours of wartime industrial production saved by the use of the welding processes in the maintenance and repair of machines of every description. We could cite from our own records innumerable instances where bronze welding has put damaged machinery back into service in a matter of hours, thus avoiding production delays of weeks and even months. Two examples will suffice:

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[3] Manager, Process Service, Dominion Oxygen Co., Ltd., Toronto, Ontario, Canada.

A 500-lb cast-iron slide of a hot-nut-making machine in a steel plant cracked. It was repaired by bronze-welding and put back into service in 9 hours. The replacement part could not have been obtained in less than three months.

A large press gear from a machine essential to production of war materials in a shell plant was broken. Again a replacement could not be obtained in less than three months. It was bronze-welded and returned to service in thirteen hours.

Similarly, countless thousands of hours of machine-tool time have been conserved by welded repairs and by building up worn parts, thus reducing required stocks of replacement parts or eliminating delays in obtaining replacements for machines where standard parts are no longer available.

War production has introduced many new welding problems not encountered in peacetime industry. For example, the large-scale manufacture of shells increased the demand for composite cutting tools almost overnight. No very satisfactory method had ever been developed by individual plants for attaching tungsten-carbide tools to shanks. An intensive study of this problem resulted in the development of a special procedure to accomplish this brazing operation so that 100 per cent satisfactory results can be obtained by even an inexperienced operator. Nearly every shell plant in Canada is now using this procedure, and it has been sent to interested industries in Great Britain, Australia, and the United States.

Production of smoke bombs required the development of automatic jigs and fixtures and a welding procedure to obtain high production and uniform high-quality welds. The process originally specified for this application would have required a very expensive initial setup involving equipment not readily available. In addition it would have required large quantities of hydrogen, a very critical gas in wartime. An alternative, simplified semiautomatic oxyacetylene process was developed which produced the necessary uniform high-quality welds and, because the unit installation cost is very low, almost any production can be obtained by using the required number of units. Ten to twelve girls are now using this procedure in one plant and are obtaining the highest consistent production of this item.

In these comments on the part played by the welding industry in Canada's war production, with particular reference to conservation of critical materials, manpower, and machine tools, we have been able to hit only a few of the high lights. However, we hope that this review will indicate in some degree the value of welding in the conservation program.

Comment by F. E. P. Griggs[4]

The part that the electrochemist is playing in the conservation of metals falls into a number of different classifications. Probably the one of greatest interest deals with the deposition of hard chrome on tools, gages, dies, fixtures, and the like, as well as the use of hard chrome in the reclamation of parts in a machine plant which have been either machined in error or where specifications have changed.

The hard-chrome plating process is not a mysterious business. It is the same fundamental chromium plate that goes on the bumper of an automobile, the main difference being that the thickness of the deposit is increased greatly, and the application of course is one of utility rather than beauty.

Electroplating and particularly the deposition of hard chrome is founded on definite engineering and scientific bases. It can be applied by the average worker if he will give some thought to the process and it is being used very successfully in a number of plants.

Perhaps a brief example of an application in one particular plant will illustrate the possibility that this process has for industry in this respect. The company involved is the John Inglis Company, Toronto, which is perhaps the most productive chrome-plating plant anywhere in the Dominion. The staff has made some comparative tests on plated and standard tools and reports a percentage increase of plated tools over steel tools, as follows: Reamers increased in life from 125 to 400 hr; twist drills, anywhere from 80 to 130 per cent; slot cutters, up to 450 per cent; V-bits, 94 per cent; milling cutters, anywhere from 100 to 200 per cent; and B-bits, up to 550 per cent.

There is a tendency to think that you can take a worn-out twist drill or a reamer and put on a mysterious coat of chrome metal over the surface and it is as good as new. However, that is not the case. Most plating now is done on new tools before they are put into use and they are replated after the chrome has worn off.

The writer has in mind one particular example recently of a plant in Western Ontario which was making large hubs for tanks. Due to an error somewhere in the plant, one machined surface had been cut 0.001 in. undersize. The forgings involved, with the labor on them were valued at approximately $250 apiece. Approximately 50 of them had been spoiled. They were reclaimed by chrome-plating at a cost of $15.

Other plates, as distinct from decorative finishes, are widely used. Heavy silver deposits in the aircraft-bearing industry are being applied where thicknesses up to $^1/_4$ and $^3/_8$ in. are deposited at very high current density and very high speed.

The acceptance by industry of tin plate by electrodeposition will, it is believed, be a fact inside of the next few months. There are presently 28 tin-plate lines operating in the United States, and the average deposit is approximately $^1/_2$ lb per base box as against $1^1/_4$ lb now currently obtained by the hot method. Speeds up to 1000 fpm and amazingly short plating times are now being obtained.

In so far as direct results have been obtained from conservation through the medium of the plating industry, it is interesting to know that cadmium, for the first 8 months of 1943, had been reduced approximately 25 to 30 tons, as compared to the corresponding period the previous year. That is despite a very material increase in aircraft production which is one of the few phases left where cadmium is allowed.

Comment by Col. M. P. Jolley[5]

The writer's remarks will concern the relationship of design to the subject of conservation under wartime manufacture, referring chiefly to guns and mechanical equipment for the Army.

Before the war and before national interest developed in the subject of defense, the peacetime designer of military equipment was avoided as rather a peculiar individual. Despite this, however, a few designers and engineers and a few concerns carried on during the peace years, and to those men and to those industries we owe a great debt for having the equipment with which to get into this war.

However, those men and concerns operated under distinct disadvantages. They were limited by funds. They were limited by fields of application. They were limited by numbers. They were limited by lack of exchange of ideas. There was little co-ordination between the peacetime designer of military equipment and the manufacturers. Often the designer was connected with a plant having obsolete equipment, and his designs were influenced by such equipment limitations.

However, under those conditions, the prewar designer worked out designs to satisfy the requirements of the Army. He gave us good designs, but wasn't always able to take into consideration the shortages of materials, the shortages of manpower, machine tools, and other items which come upon us during wartime.

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[4] Chief Engineer, Special Products, The Canadian Hanson Van Winkle Company.

[5] President and General Manager of Small Arms, Limited, Long Branch, Ontario, Canada.

Then with the designs that were available at the outbreak of war we went into wartime manufacture and immediately had unlimited funds available and the full resources of the nation behind our manufacturing program. We had a wide range of knowledge at our command from all ranks of the nation. We brought labor into our confidence. We formed labor-management committees, created suggestion plans, and got ideas from engineers, from workmen, and from everyone associated with the manufacturing industries.

With this background and a new freedom of movement, we undertook the development of wartime designs having only existing drawings to work with. Immediately it became necessary to find ways and means of doing the job better, saving valuable materials and time.

However, in getting into manufacture on a new item, we take the drawings as they are found and probably tool up for the item, later finding other ways of doing it. We have simplification and retooling programs under way. Much of the time required to get to this point might be saved if some of the ideas which we apply in wartime could be applied in peace.

So if in this war we can draw on our experience to co-ordinate the peacetime design of military equipment with up-to-date manufacturing methods, we will be in much better position should a national emergency again arise.

To do this we must maintain a national interest in defense of the country. We must spend a certain amount of money, necessary to keep abreast of the times, but more important, we must maintain the benefits of commercial knowledge through close association between the Army and the designers of military equipment, and the engineers and technicians of commercial industry. Thus as we proceed to evolve new designs on a peacetime basis, we can simultaneously consult with the engineers and men who in wartime will have to make the products.

AUTHOR'S CLOSURE

The comments of Messrs. Clarke, Duncan, Griggs, and Jolley are exceedingly interesting. They demonstrate what can be done when necessity makes it imperative that we develop new ways and means of accomplishing the same or better results in a shorter time, with less manpower and with a greatly reduced supply of materials.

The results achieved have been accomplished under great and urgent pressure. I believe that the important lesson to be learned is that many of these amazing developments can and should be carried on, not only during the immediate postwar period but into the peacetime economy of the future.

The fundamental basis of all human endeavor is to raise the standard of living of mankind to an ever-higher level. To do this we must make the most economical use of our available natural resources. We must employ to the full our inventive genius to produce new and better goods at lower cost. Unnecessary labor must be eliminated and we must use every possible means to supply all necessary food, clothing, and shelter to all mankind.

The many methods employed in conservation during this critical period of our history indicate not only the way to a successful future but also the means by which success may be attained.

HOWARD COONLEY.[6]

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[6] Director, Conservation Division, War Production Board, Washington, D. C. Mem. A.S.M.E.

Tool-Life Tests

TO THE EDITOR:

In his discussion of the subject paper,[7] at the 1943 Annual Meeting of the Society, F. J. Oliver,[8] raised an interesting point relating to the test procedure of single-point tools. His experiences in inspecting manufacturers' products are germaine but, fortunately for the tool-life tests, the variations are not nearly so extensive in range by comparison.

In the case of the machinability evaluation of the two materials of which carefully prepared test logs are available, the cutting tools and cutting fluid, size of cut, etc., would be constant. If the material is annealed, or normalized, or quenched and tempered, its structure will be fairly uniform throughout, so that it would be expected that all experimental points expressing the relation between cutting speed and tool life would approximate closely a straight line when plotted on log-log paper. Under favorable conditions four tests run at different speeds should give points which fall on this line.

If the material is cold-finished, the results from surface tests may vary widely from those of interior tests because of lack of uniformity in the metal. This condition does lead to trouble and may require more than the normal number of tests to reach conclusive results.

The example mentioned is based on the assumption that the various tools, if more than one is used, are uniform and give results equal to those obtained if only one tool is used after successive grindings. It is found that tool bits made by some companies vary in performance from tool to tool within even a small batch, while those from other companies are consistently uniform in performance.

The use of relatively small tool bits is desirable not only from the point of view of requiring less metal to grind in sharpening but also because they are more uniform in performance when the batch is heat-treated as a unit.

Where the variable is other than the tool, it is recommended that a large number of similar tools be provided, and experience will soon select the brands of most uniform performance. Where tools are prepared locally there is much greater chance for variation in quality because of lack of experience in routine production.

Mr. Oliver's question as to whether only three tools of a given type or brand are sufficient for cutting-tool evaluation may be answered yes and no. It is the writer's belief that each tool bit is consistently good or poor. If poor, its experimental data will fall consistently below the cutting speed - tool life line, and when indicated, can be discarded. It is for this reason that uniformity of quality in batches is important.

The use of the cutting speed - tool life line for evaluating the variable has been advocated by the writer for years. The line shows machinability characteristics of the variable by both its height on the log-log chart and by its slope. The data from any tool of a batch run at any speed within experimental range should give a tool life in accordance with the line. It is not thought that a tool will give good performance in one test and poor performance in another on the same log. However, this tool might be superior to another on one log, but inferior if used on another test log of different treatment or analysis.

The same applies to heavy and light cuts, i.e., superior on heavy but inferior on light, or vice versa.

It is believed there is greater variation in performance of different types of high-speed steel than in different heats of the same type. Experience has shown that one company may be more proficient in making one type of high-speed steel than another type, so that by testing several types made by each of several manufacturers, the best of each type can be found. An optimum assembly of tool grades may therefore represent several manufacturers.

O. W. BOSTON.[9]

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[7] "Proposed Standard of Tool-Life Tests for Evaluating the Machinability of Single-Point Tools, Cutting Fluids, or Materials Cut," by O. W. Boston, MECHANICAL ENGINEERING, February, 1944, pp. 130–132.

[8] Machine Tool Editor, *The Iron Age*, New York, N. Y. Mem. A.S.M.E.

[9] University of Michigan, Ann Arbor, Mich. Mem. A.S.M.E.

Mechanics Units

TO THE EDITOR:

The existence of two systems of units of mechanics has long been a source of confusion. Even if the British gravitational system should become the only one in use, this confusion will be most troublesome with dimensional equations. The engineer of the year 2000 who consults the literature of the present will be puzzled to find the dimensional equation of power, for instance, to be ML^2T^{-3} on one page and FLT^{-1} on another.

This confusion may be abated and the teaching of mechanics greatly simplified if some international commission will adopt 32.174 standard pounds as the kinetic unit of mass and the force which accelerates this mass one foot per second as the ***standard pound force.***

It is suggested that this unit be named the "gee-pound," a self-explanatory and euphonious term, which was proposed by Prof. E. R. Maurer in 1903 and has received some recognition. The term slug is based on a far-fetched analogy with sluggish. How sluggish is a baseball when struck by a bat?

JAMES E. BOYD.[10]

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[10] Emeritus Professor of Mechanics, The Ohio State University, Columbus, Ohio. Life Member A.S.M.E.

A.S.M.E. BOILER CODE

Revisions and Addenda to Boiler Construction Code

IT IS the policy of the Boiler Code Committee to receive and consider as promptly as possible any desired revisions of the rules and its codes. Any suggestions for revisions or modifications that are approved by the Committee will be recommended for addenda to the code, to be included later in the proper place.

The following proposed revisions have been approved for publication as proposed addenda to the code. They are published below with the corresponding paragraph number to identify their location in the various sections of the code and are submitted for criticism and approval from anyone interested therein.

It is to be noted that a proposed revision of the code should not be considered final until formally adopted by the Council of the Society and issued as pink-colored addenda sheets. Added words are printed in SMALL CAPITALS; words to be deleted are enclosed in brackets [ ]. Communications should be addressed to the Secretary of the Boiler Code Committee, 29 West 39th St., New York 18, N. Y., in order that they may be presented to the Committee for consideration.

PREAMBLE TO THE CODE. Add the following as the sixth paragraph of the preamble to the Power Boiler Code:

Separately fired steam superheaters which are not integral with the boiler or are separated from the boiler by stop valves are considered fired pressure vessels and their construction shall comply with Code requirements, including all piping, valves, and required safety devices, from the inlet flange to the outlet flange. If welding ends are used at the inlet or outlet of the superheater, Code requirements shall begin or end at the weld where flanges, if used, would have been placed. Such attachment welds to external connecting pipe are not within the scope of the Code, if they are not exposed to high-temperature gases.

PAR. P-102(*b*). Revise second sentence of item (2) to read:

THE WELD RIPPLES OR WELD SURFACE IRREGULARITIES, ON BOTH THE INSIDE AND OUTSIDE, SHALL BE REMOVED BY ANY SUITABLE MECHANICAL PROCESS, TO A DEGREE SUCH THAT THE RESULTING RADIOGRAPHIC CONTRAST DUE TO ANY REMAINING IRREGULARITIES CANNOT MASK OR BE CONFUSED WITH THAT OF ANY OBJECTIONABLE DEFECT. ALSO THE WELD SURFACE SHALL MERGE SMOOTHLY INTO THE PLATE SURFACE. [The weld reinforcements on both the inside and outside shall be ground, chipped and ground, or suitably machined to remove the irregularities of the weld surface so that it merges smoothly into the plate surface.]

PAR. P-278. Add the following to the second sentence of the first section:

except fire-tube boilers used for waste heat purposes only, not equipped for direct firing, need not meet the requirements of Table P-14 provided the rated steaming capacity is stamped on the boiler and safety valves of the required relieving capacity are supplied such that the provisions of Par. P-270 are satisfied.

PAR. P-290(*a*). Add the following sentence: Such dimensional limitations to operation for steam need not apply to steam scrubbers or driers provided the net free steam inlet area of the scrubber or drier is at least 10 times the total area of the boiler outlets for the safety valves.

PAR. P-301. Add the following as the second sentence of the second section:

In a separately-fired superheater installation, a stop valve is not required at the inlet or the outlet of the superheater.

PAR. P-332(*e*). Under the subtitle "Items on waterwalls, superheaters, or steel economizers," change item (4) to read: "(4) Heating surface in square feet (not required for INTEGRAL superheaters"). Add as item (5): "(5) Design temperature (required only for separately fired superheaters)."

Under the subtitle "Items on boilers," add the following as item (6):

"(6) Rated steaming capacity (required only for waste heat boilers not equipped for direct firing)."

PAR. U-2. Insert a title above this paragraph to read: "Safety Devices."

PAR. U-2. Revise first section to read:

All pressure vessels shall be protected by adequate safety and relief valves together with such indicating and control devices as will insure safe operation except that, on vessels containing substances that may, for any reason, render a safety valve inoperative, or where a leakage should be avoided, rupture disks may be used in lieu of safety valves. The relieving capacity of safety valves or rupture disks, when used, shall be sufficient to prevent a rise of pressure in the vessel of more than 10 per cent above the maximum allowable working pressures. All discharges shall be carried to a safe place. All protective devices shall be so constructed, located, and installed that they cannot readily be rendered inoperative.

PAR. U-3. Omit title above this paragraph which reads: "Safety Valves for Steam or Air."

PAR. U-3. Insert new (*c*) to read:

(*c*) Rupture disks may be used if they meet the requirements of Par. U-10 (*b*) and the relief area is at least equal to the cross-sectional area of the connection thereto (See Note).

NOTE: It is a common practice to keep the working pressure somewhat below the rupture dick bursting pressure in order to prevent its premature failure due to fatigue.

PAR. U-10. Renumber this paragraph as Par. U-9 and insert a new Par. U-10 to read:

U-10 (*a*) Rupture disks may be installed between a spring-loaded safety valve and the vessel provided:

(1) The valves are ample in capacity to meet the requirements of Par. U-2;

(2) The disk is designed to rupture at not more than the maximum allowable working pressure of the vessel;

(3) The opening provided through the disk, after breakage, shall be sufficient to permit a flow equal to the capacity of the attached valve and there shall be no chance of interference with the proper functioning of the safety valve;

(4) The connection between the disk and the safety valve is so arranged as to form a pocket in which any detached fragment of the disk will be retained, and that this space is vented to a safe point of discharge.

(*b*) Every rupture disk shall have its specified temperature and bursting pressure and lot number and be guaranteed by its manufacturer to burst within 5 per cent (plus or minus) of its specified bursting pressure.

The specified bursting pressure and temperature shall be determined by bursting two or more specimens from a lot of the same material, and of the same size as those to be used.

Every rupture disk shall have its specified bursting pressure and temperature and lot number stamped upon the flange of the disk itself or upon a metal tab permanently attached thereto.

PAR. U-66(*a*). Add the following to the last section:

except that when all of the pressure chambers are:

(1) In a common cylindrical shell;

(2) Designed for the same maximum allowable working pressure;

(3) Required to have identical Code stamping, a single report form may be used to record all of the required data and only one set of stampings need be applied to the vessel. Also when a combination of chambers, carrying different pressures but having common parts, make up a single unit the several chambers shall be properly stamped but a single data sheet, with the necessary additions, may be used.

REVIEWS OF BOOKS

And Notes on Books Received in the Engineering Societies Library

The Wright Brothers

THE WRIGHT BROTHERS. By Fred C. Kelly. Authorized by Orville Wright; Harcourt, Brace & Co. New York, N. Y., 1943. Cloth, $5^5/_8 \times 8^3/_8$ in., 340 pp., illus., $3.50.

REVIEWED BY W. F. DURAND[1]

THIS book, with the manuscript approved by Mr. Orville Wright, is the answer to the long-deferred hopes of that great aggregate of American people who for so long have wished for a reasonably full but nontechnical authoritative account of that epoch-making invention which, forty years ago on December 17, 1903, opened up to man a new degree of physical freedom. A structure of wood, fabric, and metal, mechanically driven and carrying a man, was flown under control through the air. Man had learned to fly!

This was the end of the first chapter of the development of air transport—of the use of the air as a medium of movement from one point to another in addition to the dry land and the waters of our rivers and oceans. How air transport has developed during the forty years since this first convincing demonstration is too well known to need characterization here. The first successful flight came, however, only at the end of a long history of work and study, toil and trouble, marked by difficulties and discouragements without number and calling for a rare combination of genius, patience, persistence, and an abiding faith in the ultimate triumph of their efforts.

The background for the exhibition of this rare combination of human qualities is well set forth by the author in the first three chapters of the book, showing the two boys, Wilbur and Orville Wright, as typical American youth, both with strong mechanical instincts, fascinated by the antics of a gyroscopic top and most deeply impressed with the behavior of a small toy airplane with a twisted-rubber-band power drive. Always with an urge for self-expression in mechanical form, ways and means had to be found for financing the purchase of tools and materials, and we find the boys engaging in various gainful activities—the collection of old bones as a basis for a ground fertilizer, help in the home, kite making for sale, devising a new form of chewing gum, organization of a circus (admission five cents, children under three years three cents), and so by easy stages to printing and the bicycle business which gave them their economic backing for the great enterprise.

All of this is told in agreeable sprightly narrative form; and then the author takes his story on into the events which led to their studies of gliding and gliders, and so on to the next step, the addition of power for the construction of the plane which made the historic Kitty Hawk flight of December 17, 1903. This great event and the preliminaries leading up to it are dealt with in chapters 5 and 6. The picture drawn is clear-cut and vivid and the reader can almost imagine himself running alongside the plane with Wilbur as it starts down the runway, facing into a 17 mile-per-hour head wind before the take-off. Twelve seconds of flight was not a long time, but it was long enough to give a convincing demonstration; and from that moment, the possibility of controlled human flight was assured.

Then follows, in chapters 7 to 10, the history of the developments during the next two or three years—on the one hand the amazing indifference of the press and of the general public toward this great event as news, due apparently to their refusal to believe in the reality of the performance; and on the other hand the patient continuing work of the two brothers with base in a pasture lot a few miles from Dayton, called the Huffman prairie. Here the brothers practiced whenever weather conditions would permit, in a new plane with improved engines, until in 1905, flights were made covering 11, 12, 15, 20 and 24 miles with durations of 18 to 38 minutes. This meant circling round and round this small field, giving them opportunity and practice in control in turns and under varying conditions of wind and weather. These demonstrations gave final convincing proof of the reality of human flight, but still the public at large as well as the press were slow in accepting its reality as an assured and controllable achievement. The same hesitation was found likewise in the Board of Ordnance and Fortification of the U. S. Army which apparently refused to believe such press reports as had appeared, and likewise to have so little interest in the matter as to take no steps of themselves to ascertain the reality of the flights as reported.

Discouraged by this attitude on the part of the Government, the Wrights began to consider response to the expressions of interest in Europe.

The author then presents, in chapters 11 to 15, a most interesting story of the Wrights in Europe with a demonstration plane; of negotiations and demonstrations, of meeting with royalty—King Edward VII and King Alfonso XIII of Spain, of business deals, and finally back in the U. S., with an order from the War Department for a plane capable of carrying 350 lb of "pay load at a speed of 40 miles per hour." In the final tests of this plane occurred the crash landing in which Lieutenant Thomas Selfridge, a passenger observer, was killed—the first of an ever lengthening list of those who have given their lives as a part of the price which we are paying for our progress in improving control over this new freedom of the air. And then another trip by Wilbur Wright to Europe, told entertainingly in chapter 15 under the title "When Wilbur Wright won France."

Thus finally came the end of the period of doubt and disbelief, and then the small beginning of an aviation-construction industry, problems of patents, infringements, and patent suits, the death of Wilbur Wright by typhoid fever, the absorption of Orville in patent litigation, the entry of Glenn Curtiss into the picture and the celebrated and important successful suit against him (not finally adjudicated until 1914), the most unfortunate disagreement with the Smithsonian Institution regarding the claims made by Secretary Walcott for the Langley plane, the bitterness engendered and the placing of the Kitty Hawk plane in the South Kensington Museum, London; a situation now vastly improved through the efforts and frank statements of Dr. C. G. Abbot, the present Secretary of the Institution. And so to modern days with the surviving brother, Orville Wright, taking note day by day, of the revolutionary changes which aviation has brought into all large world affairs, and especially in the great struggle in which we are now engaged.

The approval of the manuscript by Mr. Orville Wright, and the free access by the author to records and letters, would appear to insure the factual accuracy of the book as an historical document, presented, as it is, in vividly interesting narrative form. The book is cordially commended to those who have any interest in the early beginnings of what has grown to be a determining factor in all great world affairs—transport by way of the air.

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[1] Honorary Member and Past-President of The American Society of Mechanical Engineers.

Lubrication of Industrial and Marine Machinery

Lubrication of Industrial and Marine Machinery. By William Gordon Forbes. John Wiley & Sons, Inc., New York, N. Y., 1943. Cloth, $5^1/_2 \times 8^3/_8$ in., 319 pp., illus., $3.50.

Reviewed by C. L. Pope[2]

THE author has covered a rather large part of lubrication engineering without becoming unduly technical.

The first few chapters explain the basic elemental principles of distillation, blending, and chemistry of lubricants. There are several chapters describing and interpreting the results of the more useful tests of lubricants for both new and used oils.

This preparation enables the reader to readily understand the chapters on oil purchase specifications, and the reasoning behind the selection of specific lubricants for mechanical equipment.

The chapters on refrigeration equipment, bearings, gearing, turbines, machine tools, etc. are interesting as the author describes the lubrication requirements and recommends specific oil characteristics from his own experience plus accepted practice as observed in some of the larger industrial plants.

This book supplies sufficient basic information for the average engineer and will point the way for further study for those interested in advanced lubrication engineering.

Books Received in Library

Abbrevs. (A Dictionary of Abbreviations) compiled by H. J. Stephenson. The Macmillan Co., New York, N. Y., 1943. Cloth, $5^1/_2 \times 8^1/_2$ in., 126 pp., $1.75. This dictionary brings together a great number of abbreviations commonly met with in books and papers and frequently puzzling to the reader. Literary, scientific, and industrial fields are covered.

The Aircraft Annual 1944, edited by D. C. Cooke, first annual edition. Robert M. McBride & Company, New York 3, N. Y., 1944. Cloth, $6^1/_2 \times 9^1/_2$ in., 288 pp., illus., charts, $3. This is the first of a series of annual reviews which will give a comprehensive account of current activities in aviation. The text is readable and nontechnical and is accompanied by a profusion of excellent photographs. Among the topics considered are the work of the U. S. Army and Navy, the Doolittle Tokyo raid, the strategy of bombing, American air transport, and the manufacturing industry.

Aircraft Electrical Engineering. By F. G. Spreadbury. Sir Isaac Pitman & Sons, London, England; Pitman Publishing Corporation, New York, N. Y., 1943. Cloth, $5^1/_2 \times 9$ in., 272 pp., illus., diagrams, charts, tables, $6. The various ways in which electricity is used in aircraft are presented with the needs of the designer in view. The chapters deal with ignition, ignition devices, direct-current generators and motors, uses of alternating current, voltage regulation, radio supply, ripple-smoothing circuits and ripple-voltage measurements, permanent magnets, and aircraft pyrometry. A reasonable amount of mathematical and electrical knowledge is presupposed.

Analytical and Applied Mechanics. By G. R. Clements and L. T. Wilson. Second edition. McGraw-Hill Book Co., Inc., New York, N. Y., and London, England, 1943. Cloth, $5^1/_4 \times 8^1/_2$, 475 pp., diagrams, charts, tables, $3.75. The mathematical and physical theory necessary for a thorough first course in mechanics is presented for use as a college text. A great many problems are included to demonstrate both obvious applications and logical extensions of the theory. This edition has been revised on a basis of actual classroom experience with the earlier edition and contains many new problems.

Design of Machine Members. By A. Vallance and V. L. Doughtie. Second edition. McGraw-Hill Book Co., Inc., New York, N. Y., and London, England, 1943. Cloth, $5^1/_4 \times 8^1/_2$ in. 559 pp., illus., diagrams, charts, tables, $4. This text has been prepared for the use of students who have had some training in kinematics, mechanics, and factory processes. Upon these as a foundation the author develops the theory involved in the design of the elements of operating machines and points out the variations from theory required by practical applications. Considerable space has been devoted to engineering materials, factors of safety, utilization factors, and the selection of design stresses. Illustrative review problems are provided for each chapter.

Diesel Locomotives—Mechanical Equipment. By J. Draney. American Technical Society, Chicago, Ill., 1943. Cloth, $5^1/_2 \times 8^1/_2$ in., 472 pp., illus., diagrams, charts, tables, $4. The mechanical equipment of Diesel locomotives is described in detail, with specific instructions for operation and maintenance. Following the general principles of Diesel engines come several chapters on fuel-injection, lubrication, governing, and supercharging. The remaining chapters deal severally with the important types of Diesel locomotives currently in use. The electrical phases will be covered in a companion volume.

Experimental Stress Analysis, Proceedings of the Society for Experimental Stress Analysis, Vol. 1, No. 1. Papers presented at the Seventeenth Eastern Photoelasticity Conference and Experimental Stress Symposium held under the auspices of the Chrysler Institute of Engineering, Detroit, Mich., May 13, 14, 15, 1943. Published and distributed by Addison-Wesley Press, Inc., Cambridge, Mass., 1943. Cloth, $8^1/_2 \times 11^1/_2$ in., illus., diagrams, charts, tables, $3. The Society for Experimental Stress Analysis is the successor of the Eastern Photoelasticity Conferences, and this publication, the first of its proceedings, constitutes the final transactions of its predecessor. Seventeen papers are published, dealing with a wide variety of problems in the technique and applications of stress analysis.

Geometry With Military and Naval Applications. By W. F. Kern and J. R. Bland. John Wiley & Sons, Inc., New York, N. Y.; Chapman & Hall, London, England, 1943. Cloth, $5 \times 8^1/_4$ in., 152 pp., illus., diagrams, tables, $1.75. This book presents the practical essentials of solid geometry. For the development of "space intuition" a large number of exercises call for visualization of cross sections of solids in connection with reducing a problem to a number of simple problems in plane geometry. Most of the problems and illustrative examples relate to familiar objects of everyday experience or to military and naval situations.

Library Services

ENGINEERING Societies Library books may be borrowed by mail by A.S.M.E. members for a small handling charge. The Library also prepares bibliographies, maintains search and photostat services, and can provide microfilm copies of any item in its collection. Address inquiries to Harrison W. Craver, Director, Engineering Societies Library, 29 West 39th St., New York 18, N. Y.

Intermediate Course in Differential Equations. By E. D. Rainville. John Wiley & Sons, Inc., New York, N. Y., Chapman & Hall, London, England, 1943. Cloth, $5 \times 8^1/_2$ in, 213 pp., tables, $2.75. This book is intended as a bridge for the gap between elementary courses and really advanced courses, and affords an introduction to several topics of importance in the classical theory. Specific topics covered include Riccati equations, the hypergeometric equation, equations of the Fuchsian type, confluence of singularities, and Whittaker's confluent hypergeometric equation.

Lubricants and Cutting Oils for Machine Tools. By W. G. Forbes. John Wiley & Sons, Inc., New York, N. Y.; Chapman & Hall, London, England, 1943. Cloth, $5^1/_2 \times 8^1/_2$ in., 90 pp., illus., diagrams, charts, tables, $1.50. Provides, in brief form, an explanation of the fundamental principles of lubrication in relation to metal cutting and the application of various types of cutting oils to machine-tool operations. The principles of machine-tool lubrication are also discussed. The book provides practical information for the solution of problems that arise in metal cutting. The book is in part an adaptation of the author's larger book, "Lubrication of industrial and marine machinery."

Maintenance Arc Welding. James F. Lincoln Arc Welding Foundation, Cleveland, Ohio, 1943. Cloth, 6×9 in., 234 pp., illus., diagrams, charts, tables, $0.50 in U.S.A.; $0.75 foreign. This volume contains twenty-five papers which consider the uses of arc welding in maintenance work, as a means of reclaiming broken and worn equipment and fabricating replacements. Each paper discusses work in a specific plant, describing what was done, methods and costs.

Machinery's Handbook for Machine Shop and Drafting-Room. By E. Oberg and F. D. Jones. Twelfth edition. Industrial Press, New York, N. Y. Sole distributors for the British Empire: Machinery Publishing Co., Ltd., Brighton, England, 1943. Fabrikoid, 5×7 in., 1815 pp., diagrams, charts, tables, $6. In the thirty years since this work first appeared, it has become established as an almost indispensable work of reference in drafting rooms and machine shops. This new edition contains the same number of pages as the preceding one, but numerous changes have been made in charts and tables.

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[2] Lubrication Engineer, Eastman Kodak Company, Rochester, N. Y.

Marine Piping Handbook for Designers, Fitters, Operators. By E. P. Goehring. Cornell Maritime Press, New York, N. Y., 1944. Cloth, 5 × $7^{1}/_{2}$ in., 662 pp., illus., diagrams, charts, tables, $5. This handbook is designed to meet the needs of designers, fitters, and operating marine engineers. Every type of piping installation in a ship is considered.

Modern Airfield Planning and Concealment. By M. E. De Longe. Pitman Publishing Corporation, New York, N. Y., and Chicago, Ill., 1943. Cloth, 6 × $9^{1}/_{2}$ in., 167 pp., illus., diagrams, charts, tables, $4. The problem of concealing airfields is discussed by a pilot with experience in camouflage. The distinctions between camouflage and concealment are pointed out, and methods for building in maximum concealment are considered. Proper choice of airfield locations is treated. The book is intended to guide the construction of civil and military airfields.

Plastics. By J. H. DuBois. American Technical Society, Chicago, Ill., 1943. Cloth, $5^{1}/_{2}$ × $8^{1}/_{2}$ in., 435 pp., illus., diagrams, charts, tables, $3.75. A simplified presentation of the manufacture and use of the important plastics materials and products, with tables of their properties and the basic information required by engineers and designers. This revised edition contains two new chapters, on synthetic rubber and low-pressure laminates. The book is designed to be used both as a text and as a practical reference handbook.

Plastics Catalog 1944, Encyclopedia of Plastics. Plastics Catalogue Corporation, New York 17, N. Y. Cloth, $8^{1}/_{2}$ × $11^{1}/_{2}$ in., 989 pp., illus., diagrams, charts, tables, $6. The 1944 edition of this Catalog is a compendium of information upon materials, methods of engineering, molding, fabricating, finishing and assembling, and upon machinery and equipment. Other sections deal with laminates, plywood, vulcanized fiber, plastic coatings, synthetic fibers, rubber and rubber-like plastics. There is a bibliography and also a directory of sources of materials and equipment.

Principles of Modern Industrial Organization. By W. Rautenstrauch. Pitman Publishing Corporation, New York, N. Y., and Chicago, Ill., 1943. Cloth, 6 × $9^{1}/_{2}$ in., 312 pp., diagrams, charts, tables, $3.75. The proposition that production in manufacture consists of many unit operations or points of production constitutes the basis of presentation. The book as a whole deals with the problem of procedure in setting up organized relationships in the many groups of activities encountered in industrial production. Particular emphasis is placed on methods of analysis by which the activities of each department may be studied, evaluated, and improved.

Questions and Answers for Marine Engineers—Boilers and Engines. By Capt. H. C. Dinger. *Marine Engineering and Shipping Review,* Simmons-Boardman Publishing Corporation, New York, N. Y., 1943. Paper, $5^{1}/_{2}$ × 8 in., 377 pp., diagrams, tables, $2. In this second edition of these questions and answers, compiled from the columns of *Marine Engineering and Shipping Review,* the first two books have been combined. Errors are corrected, and a few substitutions of questions made, and a fuller index added.

Steam Turbine Operation. By W. J. Kearton. Fourth edition. Pitman Publishing Corporation, New York, N. Y. Sir Isaac Pitman & Sons, Ltd., London, England, 1943. Cloth, $5^{1}/_{2}$ × 9 in., 375 pp., illus., diagrams, charts, tables, $5. A practical text on the installation, running, maintenance, and testing of steam turbines, the popularity of which is shown by four editions in twelve years. In addition to instructions, the author has included descriptive matter which will enable the engineer to understand the construction of the plant and will explain the thermal and mechanical considerations that affect its operation. The chapters on glands and governing have been rewritten for this edition, and a chapter on thrust bearings has been added.

Stress Analysis for Airplane Draftsmen. By E. J. Greenwood and J. R. Silverman. McGraw-Hill Book Company, Inc., New York, N. Y., and London, England, 1943. Cloth, 5 × $8^{1}/_{2}$ in., 291 pp., diagrams, charts, tables, $3. In addition to basic information on the properties and mechanics of materials for airplane construction this book provides the following design procedures: the determination of the loads on the structure, the determination of the resulting stresses in the members, and the investigation and comparison of types of construction suitable for carrying these loads and stresses. The application of these principles to everyday problems is indicated.

Synthetic Resins and Allied Plastics by various authors, edited by R. S. Morrell. Second edition. Oxford University Press, New York, N. Y.; Humphrey Milford, London, England, 1943. Cloth, $5^{1}/_{2}$ × 9 in., 580 pp., illus., diagrams, charts, tables, $12. In the general introduction a summary is given of the chemical and physical properties of the most important classes of synthetic resins and plastics. Succeeding chapters deal with the technology of the preparation and use of these various classes of synthetics. Considerable space is devoted to the problems of resinification, and the last chapter discusses methods of identifying and testing synthetic resins and other raw materials of plastics. Chapter bibliographies are included.

Synthetic Resins and Rubbers. By P. O. Powers. John Wiley & Sons, New York, N. Y., Chapman & Hall, London, England, 1943. Cloth, $5^{1}/_{2}$ × $8^{1}/_{2}$ in., 296 pp., illus., diagrams, charts, tables, $3. The purpose of this book is to describe briefly the chemistry of synthetic resinous materials and the raw materials from which they are made. The text is divided into the following general parts: theories of polymer formation; condensation polymers; vinyl polymers; synthetic rubbers (by K. H. Weber); resins from natural products; application of synthetic resins.

Table of Circular and Hyperbolic Tangents and Cotangents for Radian Arguments, prepared by the Mathematical Tables Project, Work Projects Administration of the Federal Works Agency, conducted under the Sponsorship of the National Bureau of Standards. Published by Columbia University Press, New York 27, N. Y., 1943. Cloth, 8 × 11 in., 410 pp., tables, $5. This volume, which is a companion volume to the "Tables of Circular and Hyperbolic Sines and Cosines," published in 1939, gives circular and hyperbolic tangents and cotangents for radian arguments from 0 to 2 at intervals of 0.0001 and from 0 to 10 at intervals of 0.1. The tables are given to eight significant figures. There is a bibliography.

Table of Reciprocals of the Integers from 100,000 through 200,009, prepared by the Mathematical Tables Project, Work Projects Administration of the Federal Works Agency, conducted under the Sponsorship of the National Bureau of Standards. Published by Columbia University Press, New York 27, N. Y., 1943. Cloth, 8 × 11 in., 201 pp., tables, $4. This table expands by tenfold the scope of existing tables in this interval, which is one where interpolation between tabular entries is somewhat difficult, owing to the large differences between the successive intervals in the existing tables of Oakes and Cotsworth.

Table of the Bessel Functions $J_0(z)$ and $J_1(z)$ for Complex Arguments, prepared by the Mathematical Tables Project, Work Projects Administration of the Federal Works Agency, conducted under the sponsorship of the National Bureau of Standards. Published by Columbia University Press, New York 27, N. Y., 1943. Cloth, 8 × 11 in., 403 pp., diagrams, tables, $5. Bessel functions of orders zero and one are encountered in the general solution of boundary-value problems in the theory of potential, heat conduction, and wave motion when the domain is bounded by a circular cylinder. In particular, they occur in the problem of the propagation of electromagnetic waves with a straight wire as a guide, the theory of the skin effect for poorly conducting wires, the problem of oscillatory motion of a sphere in a viscous medium, the vibration of a heavy chain in a resisting medium, and other boundary-value problems. These tables are calculated to ten decimal places. There is a bibliography.

Teacher's Manual for Military, Marine, Vocational, and Industrial Training. By N. Moseley. Cornell Maritime Press, New York, N. Y., 1943. Cloth, 5 × $7^{1}/_{2}$ in., 208 pp., illus., diagrams, charts, tables, $2. Part 1 of this manual considers the primary requirements of the instructor and the trainee. It discusses various methods of teaching—lecture, demonstration, recitation, discussion—in the light of actual conditions in the shop, laboratory, or field. Part 2 expands on the practical aspects. Study procedures and the technique of handling students are dealt with. Special problems in industrial training programs are considered, and there is a final chapter on teaching foreign languages.

Technique of Handling People, the Eleven Secrets of Handling People. By D. A. Laird and E. C. Laird. McGraw-Hill Book Co., Inc. (Whittlesey House Div.), New York, N. Y., 1943. Cloth, $5^{1}/_{2}$ × $8^{1}/_{2}$ in., 138 pp., illus., $1.75. Eleven simple rules are given as the fundamental approach to more pleasant and advantageous relations with other people. Each one is discussed separately, with practical illustrations of its value taken from current conditions and the careers of leading men of the present time.

Thermodynamics. By J. E. Enswiler, revised by F. L. Schwartz. Fifth edition, McGraw-Hill Book Co., Inc., New York, N. Y., and London, England, 1943. Cloth, 5 × $8^{1}/_{2}$ in., 335 pp., diagrams, charts, tables, $3. The important practical topics covered are steam power, vapor refrigeration and air heat engines. The theoretical treatment of energy, the laws of thermodynamics, permanent gases, mixtures and the flow of fluids are kept to basic considerations, the whole forming an introduction to the more abstract phases of the subject. New material on absorption refrigeration, gas turbines, gas cycles, adiabatic saturation and supersaturation has been added in this edition.

This Fascinating Lumber Business. By S. F. Horn. Bobbs-Merrill Co., Indianapolis, Ind., and New York, N. Y., 1943. Cloth, 6 × 9 in., 328 pp., illus., diagrams, tables, $3.75. All phases of our lumber industry are given consideration in this informative volume. Lumbering in the West and the South, the manufacture of lumber and other forest products, methods of distribution, and the economics of the industry are discussed. Other chapters treat of warfare uses of lumber, wood preservation, timber engineering, etc.

A.S.M.E. NEWS

And Notes on Other Engineering Activities

Diesel Engineers to Hold Third Wartime Meeting, May 8–10 at Tulsa

COVERING current problems of operation and design as well as recent developments that will influence the internal-combustion engines of the future, the Seventeenth National Oil and Gas Power Conference tentative program just released shows a wide variety of interesting papers.

This meeting, the third to be held in wartime, will take place May 8–10 at the Mayo Hotel, Tulsa, Okla.

Papers to Cover Wide Field

Current problems to be discussed include control for aviation, marine, and railroad engines, governing of engine-generators in parallel, controls for pipe-line engines, operation of pipe-line stations, aircraft-engine maintenance, and exhaust-system design. Looking to the future, other papers will cover gas-turbine prospects, developments in turbocharging, and design progress in gas-Diesel engines.

Present plans for inspection trips include a visit to the maintenance shops of one of the large pipe-line companies and possible visits to a bomber assembly plant and an oil refinery.

"All-Engineers" Luncheon and Meeting

Other high lights of the meeting will be the All-Engineers Luncheon on Monday, May 8, the informal banquet that evening, and the All-Engineers Meeting on Tuesday evening, May 9, at which an unusually interesting motion picture on air-line maintenance will be presented in connection with a talk on the same subject.

Exhibit in Conjunction With Conference

A record number of manufacturers will display the latest designs in engines and accessory equipment at the exhibit held in conjunction with the Conference.

Tentative Program

MONDAY, MAY 8

10:00 a.m.

Registration

12:00 m.

All-Engineers Luncheon

2:00 p.m.

Gas Turbines and Superchargers

Present Status and Future Prospects of the Combustion Gas Turbine, by S. A. Tucker, associate editor, *Power*, New York, N. Y.

MONDAY, MAY 8 (*continued*)

Recent Developments in Turbochargers, by C. F. Harms, manager, supercharger department, Elliott Company, Jeannette, Pa.

7:00 p.m.

Informal Banquet

TUESDAY, MAY 9

9:30 a.m.

Power Plants

Design Progress in Gas-Diesel Engines and Plants, by Robert Cramer, assistant chief engineer, Nordberg Manufacturing Co., Milwaukee, Wis.

Designing Exhaust Systems for Best Engine Performance, by Ralph L. L. Leadbetter, Burgess-Manning Co., Chicago, Ill.

Panel Discussion on Operation of Engines in Pipe-Line Service, led by J. G. Norton, chief mechanical engineer, Magnolia Pipeline Co., and other leading pipe-line engineers

2:00 p.m.

Inspection trips

8:00 p.m.

Aircraft-Engine Maintenance

Air Line Maintenance, by R. A. Miller, superintendent of overhaul, American Airlines Inc., New York, N. Y.

WEDNESDAY, MAY 10

9:30 a.m.

Engine Control

Control for Aviation, Marine, and Railroad Engines, papers by W. C. Trautman, Bendix Aviation Corporation, M. A. Edwards, General Electric Co., and R. R. Stevens, Westinghouse Air Brake Co.

2:00 p.m.

Governing

Analysis of Frequency Characteristics of Governors, Drives, and Engine Generating Sets, by W. E. Skinner, U. S. Engineers, North Atlantic Division, New York, N. Y., and P. L. Giering

Hydraulic Control Methods for Pipe-Line Engines, by J. R. Polston, engineer, Stanolind Pipeline Co., Tulsa, Okla.

A. S. M. E. Calendar

of Coming Meetings

April 3–5, 1944
A.S.M.E. Spring Meeting
Birmingham, Ala.

May 8–10, 1944
A.S.M.E. Oil and Gas Power Division Meeting
Tulsa, Okla.

June 16–17, 1944
A.S.M.E. Applied Mechanics Division Meeting
Chicago, Ill.

June 19–22, 1944
A.S.M.E. Semi-Annual Meeting
Pittsburgh, Pa.

October 2–5, 1944
A.S.M.E. Fall Meeting
Cincinnati, Ohio

November 27–December 1, 1944
A.S.M.E. Annual Meeting
New York, N. Y.

(*For coming meetings of other organizations see page 44 of the advertising section of this issue*)

Program of Midwest Power Conference, Chicago, April 13 and 14

TWENTY-FOUR speakers are scheduled to address this year's Midwest Power Conference, according to the preliminary program for the 1944 meeting announced by the Illinois Institute of Technology, to be held April 13 and 14 at the Palmer House in Chicago. Co-operating with Illinois Tech in arranging the event are eight other colleges and eight engineering societies.

Following the theme, "Power Brings Victory," the conference will emphasize both war and postwar power problems.

General topics on which discussion sessions will be conducted are: central-station practice, plant maintenance, electrical power, industrial power plants, fuels, and Diesel power. Eighteen speeches dealing with these subjects by nationally known power authorities are included on the preliminary program.

Alex D. Bailey to Give Keynote Address

Alex D. Bailey, fellow A.S.M.E., assistant to the vice-president of Commonwealth Edison Company in Chicago, will give the keynote address, "Postwar Planning of the Nation's Power Supply," and J. A. Krug, director of the office of war utilities of the War Production

Board in Washington, D. C., will speak at the All-Engineers Dinner, Thursday evening.

H. B. Gear, vice-president of Commonwealth Edison Company, will be toastmaster for the dinner.

Miss Edith Clarke, central-station engineer for General Electric Company in Schenectady, N. Y., will speak on "Trends in Power System Analysis" before one of three electrical sessions.

Papers of special postwar significance will be presented in the discussion group on "Fuels." "Research in Fuels as a Postwar Necessity" will be the topic of an address by A. R. Mumford, member A.S.M.E., of the development and research department of the Combustion Engineering Company in New York. Arch L. Foster, refinery editor of the *Oil and Gas Journal*, Tulsa, Okla., will speak on "Postwar Outlook for Oil Fuels."

Two discussion sessions will be sponsored by Chicago sections of co-operating engineering societies. The session on "Central Station Practice" will be conducted by the power and fuels division of The American Society of Mechanical Engineers, while the power group of the American Institute of Electrical Engineers will sponsor one of the three electrical sessions.

A.S.M.E., A.I.E.E. Luncheons

Continuing their custom of former years, the A.S.M.E. and A.I.E.E. will also sponsor luncheons for conference guests.

The A.S.M.E. luncheon will take place Thursday noon with Dr. C. O. Dohrenwend, chairman of the engineering mechanics research at the Armour Research Foundation at Illinois Tech, as the speaker. His subject will be "Review of Experimental Stress Analysis Methods."

"Tomorrow's Outlook" will be discussed by B. W. Clark, vice-president in charge of sales for Westinghouse Electric and Manufacturing Company in East Pittsburgh, Pa., at the luncheon to be sponsored Friday by the A.I.E.E.

The conference will be opened by an address of welcome by Robert B. Harper, vice-president of the Peoples Gas Light and Coke Company in Chicago. Responding will be F. M. Dawson, dean of the college of engineering at the State University of Iowa, one of the eight co-operating schools.

The eight schools assisting Illinois Tech in arranging the 1944 meeting include: Iowa State College, Michigan State College, Northwestern, Purdue, Iowa, Illinois, Michigan, and Minnesota Universities.

Co-Operating Engineering Societies

The engineering societies helping to plan the conference are: Chicago sections of the American Institute of Chemical Engineers, the American Institute of Electrical Engineers, American Institute of Mining and Metallurgical Engineers, and The American Society of Mechanical Engineers; Illinois sections of the American Society of Civil Engineers and the American Society of Heating and Ventilating Engineers; Western Society of Engineers; and the Engineers' Society of Milwaukee.

Director of the meeting is Stanton E. Winston, member A.S.M.E., professor of mechanical engineering at Illinois Tech, who has served as an administrator of the conference since 1938.

Qualifications and Duties of A.S.M.E. Council Members Outlined

At its meeting on February 25, the Executive Committee of the Council of The American Society of Mechanical Engineers approved a statement "Membership of the Council." The statement follows:

Membership of the Council

The President, seven Vice-Presidents, nine Managers, and the last five surviving Past-Presidents are members of the Council, the traditional name used by the Society to designate its board of directors. As directors, they are responsible individually and collectively for the management of the Society. They are the trustees for the Society, a corporation with more than a million dollars in assets and an annual income of more than $500,000. The members of the Council are regarded by the members of the Society and the public as leaders in their profession.

As directors, trustees, and leaders, they are expected to possess those qualities of character, vision, leadership, responsibility, and broad understanding that will justify the faith of the members in selecting them as directors. As these men must stand before the public, they should possess abilities of dignified public address.

During the coming year, as has been customary for the past decade, the Council meets at the Annual and Semi-Annual Meetings. At the Spring and Fall meetings, members of the Council living near the meeting place sometimes join with the Executive Committee in the discussion of Society business. The Executive Committee, made up of the President, two Vice-Presidents, and two Managers, holds regular monthly sessions and acts for the Council between its meetings. Two members of the Council are selected to serve with the Finance Committee, which meets monthly. One member of the Council serves as chairman of the Board on Technology. It is customary to appoint committees made up of members of the Council to study and report on knotty problems before the Council. In addition, to each member of the Council are assigned the local sections and student branches in his general vicinity. He is expected to meet or correspond with the officers of these groups to explain Society program and policies and stimulate activity. Proper discharge of responsibility as a member of the Council therefore requires time to attend the meetings of the Council and the Society, local sections, and student branches and to deal with correspondence and matters coming by mail from the Executive Committee. If he is selected for special assignment on the executive Committee, Finance Committee, or Board on Technology, the Council member must devote still further time to his duties.

The ballots for election are canvassed on the fourth Tuesday in September. Although the new officers do not assume their responsibilities until the final day of the Annual Meeting (the first week in December), the President should have time available between the date of his election and the Annual Meeting to give a great deal of attention to the organization of the Society's committees for the ensuing year and for the study of current Society problems and activities.

Council Members Serve Without Compensation

The members of the Council serve without compensation. The President has a small fund for his expenses and a contribution is made toward the traveling expenses of the members of the Council when they attend meetings of the Council. No traveling expenses are allowed for attendance at meetings of the Executive Committee, Finance Committee, or Board on Technology. Small amounts are available for traveling to visit sections and branches. Some financial sacrifice is therefore involved in service on the Council.

The Society covers a wide field of activity. Its committee structure is large. Its responsibility for leadership and progressive development of the profession is great. While intimate knowledge of and experience with one activity of the Society may be helpful, a willingness to study the broad field of Society work and become familiar with its ramifications is even more important.

In summary, members selected to serve on the Council should possess time to do the job, ability to make some financial sacrifice, willingness to study the work of the Society, but, above all, those qualities of character, vision, leadership, responsibility, and broad understanding that a great professional body must have in its directors.

Actions of A.S.M.E. Executive Committee

At Meeting in Society Headquarters on February 25

A MEETING of the Executive Committee of the Council of The American Society of Mechanical Engineers was held at Society headquarters on February 25, 1944. Mr. Gates presided. There were present: W. J. Wohlenberg, vice-chairman, Alton C. Chick, and A. R. Stevenson, Jr., of the Committee; K. W. Jappe (Finance), W. M. Sheehan (Professional Divisions), A. R. Mumford (Local Sections); W. G. Christy, H. V. Coes, and R. F. Gagg, Council members; C. E. Davies, secretary, and Ernest Hartford, executive assistant secretary.

Professional Divisions

On recommendation of the Committee on Professional Divisions permission was granted for indication in the Membership List of all the professional divisions in which a member wishes to register.

War Production Committee

The Executive Committee voted to transmit notes of appreciation of the War Production Committee to the A.S.M.E. Local Sections for their co-operation "in connection with visits of the chairman during the past year to some 39 local sections," and to Ernest Hartford and the staff at headquarters for their "intelligent and effective co-operation in furthering the efforts of the War Production Committee."

Nominating Committee

It was announced that a statement for the guidance of the nominating committee, "Membership on the Council," had been approved by letter ballot. This statement will be found on page 280 of this section.

Employment Clearing House

The President announced the appointment of the personnel of the committee to study the employment problem, especially the Employment Clearing House, as J. E. Walters, chairman, M. M. Boring, and N. H. Memory.

Membership Development

The personnel of the newly appointed Committee on Membership Development was announced as follows: N. O. Wynkoop, chairman, W. M. Sheehan (Professional Divisions), J. N. Landis (Local Sections), and H. E. Degler (Relations With Colleges).

Standardization of Steam Turbines

The Standardization Committee was asked to reconstitute the former Special Committee on Standardization of Steam Turbines to consult and work with the American Institute of Electrical Engineers. [This former committee reported at the Dec. 3, 1943, meeting of the Council and was discharged.]

John E. Sweet's Medals

The secretary reported that four bronze medals, which had belonged to John E. Sweet, third president A.S.M.E., had been presented to the Society by Mrs. J. D. Stone, niece of Professor Sweet. He also reported the gift to the Society by Col. S. John Thompson of a model of Hero's engine.

Virgil M. Palmer

The Committee noted with regret the death, on Feb. 16, 1944, of Virgil M. Palmer, chairman of the Registration Committee.

William Littlewood Is Appointed to N.A.C.A.

William Littlewood, vice president of American Airlines, Inc., has been appointed by President Roosevelt a member of the National Advisory Committee for Aeronautics for a term of five years, succeeding Dr. George J. Mead, who, because of poor health, asked not to be considered for reappointment. Membership on the N.A.C.A. carries no compensation.

The N.A.C.A. is the Federal Agency charged by law with the conduct of research and development to improve America's aircraft. In time of war it functions as a research and engineering facility of the Army and Navy. Mr. Littlewood will bring to the N.A.C.A. the viewpoint of an expert in air transportation.

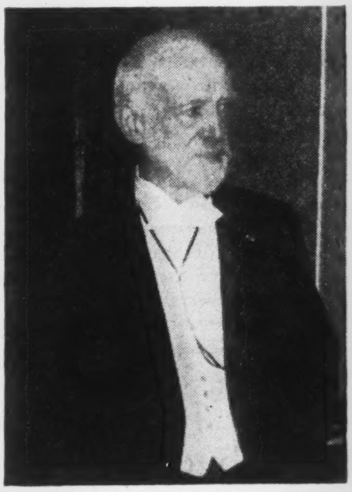
Mead and Doherty Made Honorary Members, E.I.C.

At the annual meeting of The Engineering Institute of Canada, Feb. 10–12, 1944, two members of A.S.M.E. were made honorary members of the Institute: Daniel Webster Mead, consulting engineer, Madison, Wis.; and Robert E. Doherty, president, Carnegie Institute of Technology, Pittsburgh, Pa.

W. F. Durand Honored

On March 4, at the Hotel Statler, Washington, D. C., some two score friends of Dr. W. F. Durand, honorary member and past-president of The American Society of Mechanical Engineers, attended a dinner in his honor on the occasion of his 85th birthday (March 5).

Tributes to Dr. Durand were spoken by Rear Admiral J. A. Furer, for the United States Navy; Rear Admiral A. H. Van Keuren, for the Society of Naval Architects and Marine Engineers; William L. Batt, for The American Society of Mechanical Engineers; Col. C. E. Davies, for the United States Army; Dr. Karl Compton, for the National Academy of Sciences; Dr. Jerome Hunsaker, for the National Advisory Committee for Aeronautics, and the Institute of the Aeronautical Sciences; Dr. Vannevar Bush, for the Office of Scientific Research and Development; Prof. F. O. Ellenwood, for Cornell University; Dr. Charles Vincent Taylor, for Stanford University; Dr. George A. Baitsell, for the Society of the Sigma Xi; and Dr. Ross G. Harrison, for the National Research Council.



WILLIAM F. DURAND

To these tributes, Dr. Durand responded with reminiscences of his long and varied career.

Dr. Frank B. Jewett, president, National Academy of Sciences, who presided at the dinner, presented Dr. Durand with the newly published "W. F. Durand Anniversary Volume" of papers selected from those that had been presented by the guest of honor in past years before engineering and scientific societies.

On behalf of the Institute of Aeronautical Sciences, Lester D. Gardner, executive vice-president, handed Dr. Durand a medallion commemorating his 85th birthday.

Award of Guggenheim Medal

The Daniel Guggenheim Medal Board of Award has announced the award of the Guggenheim Medal for 1943 posthumously to Edmund Turney Allen, "for major contributions to aeronautics leading to important advances in airplane design, flight research, and airline operation; particularly for the presentation of new methods for operational control and for the development of scientific and systematic methods in the flight-testing of aircraft for basic design and performance data."

Mr. Allen was killed February 18, 1943, in the crash of a new Army bomber which he was testing.

The medal and its accompanying scroll will be presented to Mrs. Allen in Seattle on behalf of the Medal Board by Mr. P. G. Johnson, president of Boeing Aircraft Company.

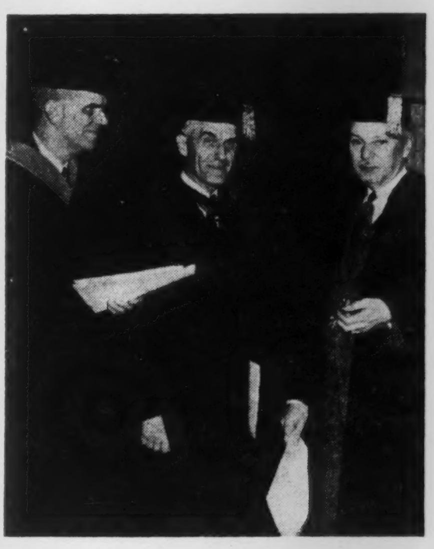
Faraday Medal Awarded to Dr. Irving Langmuir

Irving Langmuir, associate director of the General Electric Research Laboratory, A.S.M.E. Holley Medalist in 1934, has been awarded the Faraday Medal of The Institution of Electrical Engineers in London, according to a radiogram he has received from Stanley Angwin, president of the Institution. Plans for its actual presentation will be made later.

James D. Cunningham Awarded Degree by I.I.T.

James D. Cunningham, fellow A.S.M.E., was awarded an honorary doctor of engineering degree by Illinois Institute of Technology Feb. 21 at its 50th anniversary convocation. Mr. Cunningham is president of Republic Flow Meters Company, Chicago.

The citation given Mr. Cunningham read: "For unselfish service to engineering education through his vision and leadership, and for his ability as an engineer, executive, and civic leader who, by his example, has brought honor to his profession and has made distinguished contributions to American industry, to his community, and to the nation."



HONORED BY ILLINOIS INSTITUTE OF TECHNOLOGY

(James D. Cunningham, fellow A.S.M.E., right, is shown at Illinois Institute of Technology's 50th anniversary convocation, at which he was awarded an honorary doctor of engineering degree. At left is Illinois Tech's President Henry T. Heald, member A.S.M.E., and in center is Edward C. Elliott, who received an honorary doctor of science degree.)

Wickenden's "Second Mile" Republished by E.C.P.D.

THE famous address before The Engineering Institute of Canada in 1941 by William E. Wickenden, Member A.S.M.E. and president Case School of Applied Science, "The Second Mile," has been reissued by The Engineers' Council for Professional Development under the title, "The Second Mile—A Resurvey, 1944."

E.C.P.D. editions of the original address were distributed to the extent of approximately 21,000 copies. So popular was the address that E.C.P.D. persuaded President Wickenden to revise it somewhat with the particular object of presenting the engineering profession to the young engineer. The text was shortened, the style modified to make it more appropriate and appealing, and a section, "Does an Engineer Need His Profession?" was added. The new material is published in this issue, pages 253 and 270.

Copies of the new edition, "The Second Mile—A Resurvey, 1944," may be obtained by addressing the Engineers' Council for Professional Development, 29 West 39th St., New York 18, N. Y. The price is $3 per hundred; 5 cents a copy in small lots; and 10 cents for single copies.

Lamme Medal Awarded to Arthur H. Kehoe

THE 1943 Lamme Medal of the American Institute of Electrical Engineers has been awarded to Arthur H. Kehoe, vice-president of the Consolidated Edison Company of New York, Inc., "for pioneer work in the development of alternating-current networks and associated apparatus for power distribution."

It is expected that the medal and certificate will be presented to him at the Summer Technical Meeting of the Institute which is to be held in St. Louis, Missouri, June 26–30, 1944.

The Lamme Medal was founded as a result of a bequest of the late Benjamin G. Lamme, chief engineer of the Westinghouse Electric & Manufacturing Company, who died on July 8, 1924, to provide for the award by the Institute of a gold medal (together with a bronze replica thereof) annually to a member of the American Institute of Electrical Engineers, "who has shown meritorious achievement in the development of electrical apparatus or machinery" and for the award of two such medals in some years if the accumulation from the funds warrants. A committee composed of nine members of the Institute awards the medal.

E.I.C. Meets at Quebec

Fifty-Eighth Annual Meeting

AT the 58th Annual Meeting of The Engineering Institute of Canada, held at the Hotel Frontenac, Quebec, Canada, Feb. 10–12, De Gaspe Beaubien was inducted as the new president.

K. M. Cameron, president E.I.C., was chairman at the annual banquet on Friday evening when the induction took place. Speaking at the banquet was the Honorable Adélard Godbout, prime minister of the Province of Quebec. Medals and prizes were conferred.

At the luncheon on Friday, at which Hector Cimon, vice-president of the Institute for the province of Quebec presided. W. L. Batt, past-president and honorary memberA.S.M.E., vice-chairman of the War Production Board, and president SKF Industries, Inc., spoke. His subject was "Management's Need of Broader Vision."

On Thursday René Dupuis, chairman of the Quebec Branch of the Institute, presided at a luncheon which was addressed by J. B. Carswell, president, War Assets Corporation, Montreal, who chose for the title of his address "They Shall Beat Their Swords Into Plowshares."

Honorary Degrees Conferred

A special convocation was held on Thursday evening at Laval University at which time His Eminence, Cardinal Rodrigue Villeneuve, Chancellor of the University, conferred the honorary degrees on K. M. Cameron, president E.I.C. and chief engineer of the Department of Public Works of Canada, and on Brigadier Antonin Thériault, chief superintendent of arsenals, Department of Munitions and Supply of Canada.

Professional sessions held during the meeting were devoted to discussions of power projects, postwar planning, soil stabilization, industrial research, and social-security planning.

On Saturday members and guests of the Institute took part in an excursion on one of the Department of Transport's ice breakers.

Representing the A.S.M.E.

Representing The American Society of Mechanical Engineers at the E.I.C. meeting were President and Mrs. R. M. Gates, Col. C. E. Davies, secretary, and Ernest Hartford, executive assistant secretary.

The Herman Schneider Memorial Dedicated at Cincinnati

THE dedication dinner of the Herman Schneider Memorial, new home of the Engineering Society of Cincinnati, was held at the Netherlands Plaza Hotel, Cincinnati, Ohio, March 13, 1944. Dean Ford L. Wilkinson, Jr., Speed Scientific School, Louisville, Ky., represented the A.S.M.E. at the dedication. Charles F. Kettering, A.S.M.E. medalist, 1940, delivered the address.

The Herman Schneider Memorial was made possible by a group of industrial executives, headed by Frederick V. Geier, associate A.S.M.E., president Cincinnati Milling Machine Company, and is named for the late Herman Schneider, founder of the co-operative engineering courses at the University of Cincinnati. The new headquarters of the Engineering Society of Cincinnati contains two auditoriums, committee rooms, lounge, offices, and a technical library.

A.S.M.E. Consulting Engineering Group Appoints Committees

THE organization of the Consulting Engineering Group and committees as authorized is proceeding rapidly. The following committee appointments have been made:

Committee on Cost

M. X. Wilberding, Washington, D. C., *Chairman*
William A. Shoudy, New York, N. Y.
Julius G. Berger, Newark, N. J.

A committee meeting is planned in New York in the near future to initiate the work on preparing a supplement to the Manual of Practice, covering the recommended basis of accounts and other such matters.

Committee on Contract Forms

Frank H. Prouty, Denver, Col., *Chairman*
James M. Todd, New Orleans, La.
Arthur C. King, Chicago, Ill.

Committee on Co-Operation With Other Societies

Warren H. McBryde, New York, N. Y., and San Francisco, Calif., *Chairman*

The Remaining members of the Committee are yet to be appointed.

Committee on Manual of Practice Revisions

S. Logan Kerr, Philadelphia, Pa., *Chairman*

A proposal has been made by a Canadian Engineer for close co-operation with The Engineering Institute of Canada. This will be discussed at the March 22 meeting of the Joint Committee on Co-Operation Between The American Society of Mechanical Engineers and The Engineering Institute of Canada.

Report on Textile Industries of China and Japan

THE secretary of the A.S.M.E. Textile Division, W. W. Starke, calls attention to a report, "The Textile Industries of China and Japan," by Fessenden S. Blanchard, president, Textile Research Institute, Inc., 10 East 40th St., New York 16, N. Y.

Our purpose of the report "is to review briefly developments in the textile industries of China and Japan since 1917 and to attempt to size up what the postwar problems and opportunities may be.

Statistical tables and a bibliography are included in an appendix.

Did You Ever Attend the University of Glasgow?

PROF. C. J. FORDYCE, M.A., Clerk of Senate, the University of Glasgow, has asked for assistance in order to complete the record of business connections and addresses of former graduate and nongraduate students of the University.

It will be much appreciated if all former students will communicate with Professor Fordyce giving him the afore-mentioned information.

President's Page

THIS is a day of opportunity for our profession—opportunity not only for service to our country in wartime but also to prepare for a broader peacetime service than has ever before been open to engineers.

The war is disclosing new vistas. American industry must gear itself to peacetime production on a scale without precedent. That is largely an engineering job. The new technology this profession of ours has created, and is now creating in the midst of war, must be made available to wider civilian uses. We have to meet the accumulated needs of people who will insist on benefits they now know to be within reach.

A war-torn but industrially awakened world will require the service of engineers, not only for repair and reconstruction of its productive facilities, but also for a new productiveness.

Our Latin-American neighbors, from the Rio Grande to the Straits of Magellan, want to raise their standards of living by increasing their productivity. They have seen what modern engineering has done and can do for industrial nations. They are eager to share its benefits.

The peoples of Europe, looking for early deliverance from their oppressors, look to us also to show them how to rehabilitate their industries and modernize them, to use their material and human resources efficiently for their own welfare as self-supporting peoples at a higher level of comfort and security.

Asia is awakening. Turkey and Iran and Iraq, India with its vast population, have seen within their borders how modern machines and modern engineering can be used to get things done that need to be done. They want to learn how.

An eminent member of the Chinese Supply Mission in this country, telling an American audience a few days ago of China's postwar plans, said China will need "a staggering total of mechanical men and machines," largely from America. That will include, he said, 45,000 mechanical engineers alone, "not including others required for training purposes."

Probably all these needs cannot be met. These peoples may not have prospects that will justify aid from abroad for all the industrial development they plan. We ourselves may not be able to advance, so fast as we hope, toward our own peacetime goals. But it is obvious that the world is making an unprecedented demand on the engineering profession—that our profession faces an opportunity beyond any we have ever known.

Within the membership of our Society there is a vast store of engineering experience and skill that can be applied to these needs—in research, in production, in training. It is the purpose of the Society to encourage and assist its membership to make the most of this unparalleled opportunity.

(Signed) R. M. Gates, *President*, A.S.M.E.

Venturi Tubes and Venturi Meters

At a recent meeting of the A.S.M.E. Power Test Codes Committee several members of the committee, who have frequent use for venturi tubes in the measurement of the flow of water, expressed the opinion that Par. 4 of the publication on "Flow Measurement by Means of Standardized Nozzles and Orifice Plates," published in July, 1940, should be amplified to cover the precautions and procedures necessary to insure precise flow measurements with the venturi tube.

The Power Test Codes Committee approved the revision and extension of this paragraph and requested W. A. Carter, chairman of Technical Committee No. 19 on Instruments and Apparatus, to arrange for the drafting of such a revised paragraph. The following wording constitutes the report of Committee No. 19 which has the approval of the members of the standing committee.

"Par. 4. The venturi tube, as now used in the United States, is largely the product of two manufacturers, each employing slightly different shapes with varying inlet and cone roughness, possesses an accuracy equal to that of either the thin-plate orifice or the long-radius flow nozzle, when properly made and properly installed. Even when the construction and finish of the venturi tube itself conform in all respects to the designs and specifications of the manufacturer, the rates of fluid flow derived from the meter's indications may be in error to an unacceptable degree if the piping arrangements preceding the meter are such that the fluid enters the meter under distorted flow conditions. Distortions of velocity traverse, helical swirls or vortices will all endanger the accuracy of the coefficient of any of these primary devices.

"Before a person uses a venturi tube and the coefficient furnished with it in an important measurement such as an acceptance test, he should make certain that the construction and finish of the tube conform to the manufacturer's design specifications, and also that it is properly installed. Items to be particularly considered in the inspection of the tube are: the diameter of the inlet section should match that of the connecting pipe; the inlet cone should have uniform roughness around its periphery; the surfaces around the pressure openings in the inlet and throat sections should be flush with the surrounding surfaces, and the corners of the holes should be substantially sharp and free from burrs; the junction between the inlet cone and the throat liner should be smooth; the surface of the throat should be smooth and its actual diameter checked. Should the venturi tube not pass such inspection satisfactorily, its condition should be corrected or it should be given an individual calibration.

"When installing venturi tubes, it is recommended that the instructions given in the section on Installation should be followed."

War Shipping Administration Needs Men

From time to time in these pages attention has been directed to the need of the War Shipping Administration for licensed engineers for the Merchant Marine. Another call for engineers for this service has been received with a request that emphasis be laid on the need.

More than 2000 former ship engineers, from third assistant to chief, returned to the maritime industry from shore employment to help man the American wartime merchant fleet in the past 18 months and 2500 others were given assignments to ships following completion of marine engineer training courses conducted by the War Shipping Administration.

Mechanical, electrical, and marine engineers with maritime licenses now working in industries ashore are urged to return to sea where their skill is needed.

The Merchant Marine also offers opportunities to men who have completed three years or more of engineering at an accredited college. Men who qualify may start at a wiper's rating and sit for third assistant engineer licenses after as little as three months at sea, with possible raise in grade every six months.

Following are some facts for men qualified for merchant marine off-shore duty in one of the critical ratings:

Where to Report

Engineers available for this duty should report to the Recruitment and Manning Organization, War Shipping Administration, in any of the following places. *Atlantic Region:* New York, Boston, Philadelphia, Baltimore, Norfolk, Charleston, Savannah. *Pacific Region:* San Francisco, Wilmington (California), Portland, Seattle. *Gulf Region:* New Orleans, Mobile, Tampa, Miami, Jacksonville, Houston, Port Arthur. *Great Lakes Region:* Chicago, Cleveland, Detroit. *River Region:* St. Louis, Pittsburgh.

What to Bring

Bring your license and any other seaman's papers you possess (or diploma or transcript of college engineering courses, if not a seaman), your birth certificate or other proof of citizenship. U. S. Employment Service consent is required for mechanical engineers (critical occupation) transferring from one industry to another.

What to Expect When Reporting

Stanby and subsistence pay from $6.50 a day for able seamen to $10 a day for chief engineers, pending assignment, is provided by RMO for men who have left shoreside employment for the Merchant Marine.

Insurance

$5000 insurance against loss of life under enemy attack is provided free; additional insurance at small cost.

Wages

Average pay per month (bonus usually doubles base wages in deep-sea shipping off Atlantic and Pacific Coasts): chief engineer, $381.25; 1st assistant engineer or chief mate, $250; 2nd assistant engineer or 2nd mate $215; 3rd assistant engineer or 3rd mate, $192.50; able seaman, $110.

J. E. McEachern Honored

Award of the Nicaraguan Medal of Distinction to Maj. Joe E. McEachern, Memphis, Tenn., Jun. A.S.M.E., was announced recently by Army officials. The presentation was made by President Anastasio Somoza of Nicaragua in recognition of important service rendered in the construction of the recently completed portion of the Pan-American highway in that country.

Major McEachern was chief of operations for a section of the highway near Managua, the capital, for the last year of construction. He was assigned to the Nicaraguan project after completing a year as engineer supply officer at a depot in the Panama Canal Department. Previously, he was employed by the Panama Canal as a civilian engineer.

Commissioned an Army reserve officer in 1931 upon completion of military training at the University of Tennessee, he was associated with the U. S. Engineers at Memphis until 1939 when he came to Panama. He entered active duty Aug. 20, 1941, and was promoted to the rank of major Sept. 15, 1942.

A.I.E.E. Nominations

Nominations of candidates for offices of the American Institute of Electrical Engineers which become vacant Aug. 1, 1944, have been reported, as follows:

President, C. A. Powel, manager, Headquarters Engineering departments, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.

Vice-President, R. T. Henry, Buffalo, N. Y., J. F. Fairman, New York, N. Y., M. S. Coover, Ames, Ia.; R. W. Warner, Austin, Texas; and C. B. Carpenter, Portland, Ore.

Directors, P. L. Algee, Member A.S.M.E., Schenectady, N. Y.; M. J. McHenry, Toronto, Ontario, Canada; and D. A. Quarles, New York, N. Y.

Treasurer, W. I. Slichter, Fellow A.S.M.E., New York, N. Y.

Aviation Division of A.S.M.E. to Hold Big California Meeting

The Aviation Division of The American Society of Mechanical Engineers with the excellent co-operation of the A.S.M.E. Southern California Section is planning to hold a four-evening meeting, June 5 through 8 at the University of California, Los Angeles, Calif.

As we go to press word comes that three simultaneous sessions are being arranged for each evening with leading aviation engineers as speakers. An attendance of not less than three thousand is expected.

It is hoped that details of the meeting will be in shape to publish in the May issue. If you are interested in further information on this tremendous aviation gathering before that time, write to the Secretary of the A.S.M.E., 29 West 39th St., New York 18, N. Y.

Among the Local Sections

Importance of Photography Told to Large Erie Audience

Harris B. Tuttle Presents Complete Description of Its Wartime Uses

The training time for the average soldier is reduced by more than 40 per cent through the use of motion pictures as a visual aid, H. B. Tuttle of the Eastman Kodak Company's Sales Service Department told 300 members and guests of the Erie Section on January 31. Mr. Tuttle's illustrated address set forth many important uses of photography as an instrument of war.

One of the largest production units for training films, he explained, is operated by the Signal Corps and located in the studios at Astoria, Long Island, formerly used by Paramount Motion Pictures. There photographers are trained for field units, and training films are made for use in instructing all Army personnel.

The importance of aerial photography, he added, has increased likewise; many bombers today being equipped with mapping cameras capable of making aerial views at altitudes of 35,000 feet and more. Some planes are even equipped with darkroom facilities so that photographs can be processed and the resulting pictures delivered by parachute to a field base within a few minutes.

He pointed out that other planes are equipped merely to make aerial pictures. As soon as the pictures have been made, the undeveloped film is dropped by parachute where it is picked up by a field jeep and taken to a field tent darkroom where the film is developed and prints are made.

These prints may then be studied by a staff of experts and plans made for the next military operations.

High-speed photography, Mr. Tuttle advised, now makes it possible to study the behavior of exploding shells, the speed of bullets, and the effects of gunfire. Antiaircraft fire may be photographed, enabling ground crews to determine the height to which gunfire penetrates and to develop suitable methods for counteracting it.

These and scores of other wartime uses of photography were set forth by Mr. Tuttle, who presented a full description of photographic techniques on the home front, including identification passes for persons in war plants, and photographic communication such as V-mail.

Atlantic Section Holds Dinner Meeting

A dinner in honor of Dr. J. E. Younger was held on January 26, at the Atlantic Athletic Club, Atlanta, Ga. Dr. Younger was the guest speaker and talked on the subject of "Airplane Structures, Past, Present, and Future." A spirited discussion followed the lecture.

R. M. Gates Speaks at Baltimore Section

"What's Ahead for the Engineer?" was the question asked by Robert M. Gates, president of the A.S.M.E., and guest speaker at the January 24 meeting of the Baltimore Section. Mr. Gates believes that the professional society can be of great service to the men who will return to civilian pursuits and to industry. Speakers were present to represent industry, education, and public works.

G. F. Harms Guest Speaker at Central Penn. Section

At the February 17 meeting of the Central Pennsylvania Section held at Pennsylvania State College, State College, Pa., G. F. Harms, manager of the supercharger department, Elliott Company, spoke on the subject of "Turbocharger Application on 4-Cycle Diesel Engines." Mr. Harms discussed the operation of the Buchi supercharging system and showed the application to 4-cycle Diesel engines. His talk was illustrated with slides.

Junior Division Sponsors Meeting of Chicago Section

J. O. Reinecke, partner of Barnes & Reinecke Company, Chicago, Ill., industrial designers and engineers, spoke on the subject of "Plastics as Engineering Materials," at the February 14 meeting of the Chicago Section, which was sponsored by the Junior Division. Mr. Reinecke gave a résumé of the new developments in the plastics industry and pointed out numerous applications of these materials in engineering design.

This Section met again on February 28, to hear Dr. H. A. Winkelmann, Technical Director, Dryden Rubber Company, Chicago, Ill., comment on "Synthetic Rubber, Present and Future." Dr. Winkelmann gave a nonchemical review of the rubber problem from a current and future viewpoint and showed samples of various types of synthetics to demonstrate the characteristics of each in comparison with rubber.

History of Navigation Told at Cleveland Section

John J. Nassau spoke on the subject of "Evolution of Navigation," at the February 10 meeting of the Cleveland Section. This was a brief presentation on the history of navigation and the methods that have been used since the time of Columbus.

Joint Meeting Held by Dayton Section

The Dayton Section on February 29 held a joint meeting with the Dayton Engineers' Club, at which Dr. Gaston F. DuBois, of the Monsanto Chemical Company, spoke on the subject of "Applied Chemistry in Industry." Forty-six members were in attendance.

Fort Wayne Section Hears About Ball Bearings

On February 9, the Fort Wayne Section held a meeting at the Y.M.C.A. in Fort Wayne, Ind., to hear Hudson T. Morton, speak on the subject of "Design, Manufacture, and Applications of Ball Bearings." Mr. Morton explained the manufacturing processes for balls and races. He showed how the proper bearing is selected for a particular job and stressed the importance of proper lubrication. His talk was illustrated with slides and was followed by a question session.

Second War-Production Conference Held at Louisville

The second War Production Conference was held at the Brown Hotel, Louisville, Ky., on February 9. Attendance at the various sessions was as follows: Welding, 91; Machine Shop Problems, 27; Industrial Hygiene in War Industries, 57; Panel on Chemical Industries, 57; Panel on Wood-Industries Problems, 42, and Panel on Manpower Problems, 317.

War-Production Conference Held at New Orleans Section

A War Production Conference, at the request of the War Production Board, was held by the New Orleans Section on January 13, at the St. Charles Hotel, New Orleans, La. Four general topics were covered in separate discussion panels of the open-forum type, as follows: "Manpower Problems," "Preventive Maintenance," "Industrial Safety," and "Welding Problems." Panel chairmen and discussion leaders were carefully chosen from representative industries. An interchange of practical ideas was presented on production methods among production engineers, shop superintendents, foremen, safety directors, and engineers, personnel managers and other key employees. The quality of the panels was reported superior as a whole to those previously given and a far better exchange of ideas accomplished.

Substitute-Steel Experiences Cited at Milwaukee Section

Practical experiences with various grades of substitute steels, with specific recommendations, were discussed by Roy Allen, of the Republic Steel Corporation, Chicago, Ill., before the Milwaukee Section on February 9, at the Knickerbocker Hotel, Milwaukee, Wis. Mr. Allen touched on the heat-treatment required by the various NE steels and relative effects of deep-freeze treatment.

Engineering Research Résumé Given at Raleigh Section

Preston R. Bassett, vice-president in charge of engineering of the Sperry Gyroscope Company, Brooklyn, N. Y., at the February 14 meeting of the Raleigh Section, spoke on "War Developments Through Engineering Research and Their Peacetime Use." Mr. Bassett gave a brief but concise résumé, beginning at the 19th Century when wars depended on rifles, to present-day usages of mechanically operated mechanisms.

Plans for the Future Presented at Boston Section

The problems of postwar employment and what the engineering profession can do about it were presented at a meeting of the Boston Section on February 17, by Robert M. Gates, president A.S.M.E. Mr. Gates talked on the subject of "Plans for the Future."

Subject at Ithaca Section Is "Commissioning of Ships"

At the Ithaca Section meeting on January 26, Lieut. Comdr. George B. Gilbertson spoke on the subject of "Commissioning of Ships." Lieutenant Gilbertson explained in detail his experiences in commissioning new naval vessels of small size. A total of 60 were in attendance.

This Section met again on February 15 to hear C. F. Ramseyer of H. A. Brassert Company, New York, N. Y., speak on the subject of "The Process and Equipment for Making Sponge Iron," which proved extremely interesting.

Rochester Section Reports Successful Meeting

One of the most successful meetings ever held by the Rochester Section was reported by A. W. Schuster, chairman of the Section. The meeting was held on February 10, at which Prof. Herbert L. Seward spoke on the subject of "Raising the U.S.S. *Lafayette.*"

Electronic Fundamentals Briefed by A. J. Germain

A meeting was held on January 19 at the Nelson Hotel, Rockford, Ill., by the Rock River Valley Section at which A. J. Germain of the Westinghouse Electric & Manufacturing Company, was the guest speaker. Mr. Germain talked briefly on the fundamentals of "Electronic Application—Past, Present, and Future," yet in no uncertain terms indicated he was not in accord with the present belief that electronics is the solution to all problems. He stressed his point that its use must be balanced against economy. A total of 120 members and visitors were in attendance.

Lubrication Is Subject at St. Joseph Valley Section

According to reports the recent meeting held in the Engineering Auditorium of the University of Notre Dame was very successful. An audience of 150 persons heard L. C. Stanford of the Sinclair Oil Company talk on the subject of "Lubrication." His comments were highspotted by a sound film.

At the February 12 meeting a social get-together was held by the local chapters of all the engineering groups in South Bend, Ind.

San Francisco Section Hears J. E. Philpot

At the February 17 meeting of the San Francisco Section, held at the Engineers' Club of San Francisco, J. E. Philpot of the Taylor Instrument Company, spoke on the subject, "Place of Automatic Control Equipment in Modern Industry." Mr. Philpot gave a general description of modern developments and applications of control equipment.

Aviation Progress Outlined for North Texas Section

Progress of aviation, how it has effected and will affect our future economic and personal lives, was outlined by R. E. Whitmer at the Feb. 21 meeting of the North Texas Section. Mr. Whitmer, in his subject of "Aviation and the Future," briefly but thoroughly outlined air cargo work and the type of commodities expected to be handled.

Dr. A. A. Bates Speaks at Waterbury Section

On January 27, the Waterbury Section met at the Hotel Elton, Waterbury, Conn., to hear Dr. A. Allen Bates speak on the subject of "Engineering Materials of the Future." Dr. Bates's subject covered the fundamental properties of and achievements with iron, aluminum, wood, plastics, and other important materials.

This Branch met again on February 24 when the tremendous advances made in the manufacture of glass were brought out by Charles John Phillips. Mr. Phillips chose as his topic, "Recent Developments in Glass," disclosing the fact that during the present war, glass has reached a new level of usefulness.

Condensers and Pumps Discussed at South Texas Section

The South Texas Section held a meeting on February 3, in the Sam Houston Room, Rice Hotel, Houston, Texas. David W. R. Morgan, vice-president of the A.S.M.E., and works manager of the Steam Division, Westinghouse Electric & Manufacturing Company, Philadelphia, Pa., spoke on the subject of "Condensers and Pumps." Mr. Morgan also discussed gas turbines and used a number of lantern slides in connection with this talk. A total of 100 were in attendance.

Joint Dinner Meeting Held by West Virginia Section

The West Virginia Sections of A.S.M.E. and the A.I.E.E. held a joint meeting in The Daniel Boone Hotel, Charleston, W. Va., on January 25, at which approximately 150 members of the societies and their friends attended. Preceding the meeting, a dinner was given in honor of the speaker of the evening, R. C. Bergvall, assistant to the vice-president in charge of engineering, Westinghouse Electric & Manufacturing Company. Mr. Bergvall's subject was "Influence of New Materials on Future Design."

The West Virginia Section of both societies also will hold a joint meeting on March 28. Preceding the meeting, a dinner will be held in honor of the speaker of the evening, A. E. Caudle, engineer in the Blower and Compressor department of The Allis-Chalmers Manufacturing Company, Milwaukee, Wis.

Western Massachusetts Holds Joint Dinner Meeting

The annual joint dinner meeting of the Engineering Society of Western Massachusetts and the Springfield Section of the A.I.E.E. was held at the Highland Hotel in Springfield on February 15, with 85 members and guests present at the dinner and 130 at the meeting which followed. Newly elected members were then introduced, after which the death of a past president of both groups, Fred L. Hunt, was announced. Following the business session Carl J. Madsen, electronic engineer, Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., spoke on "Electronics." Preceding his lecture, an instructive sound moving picture, "Electronics at Work" was shown.

A.S.M.E. Sections

Coming Meetings

Bridgeport. April 20. Dinner at the Stratfield Hotel in honor of W. R. Webster who will receive his A.S.M.E. Fifty-Year Button.

Chicago. April 3 or 10. Meeting of the Junior engineers.

April 17. Transportation Division to meet.

Metropolitan. April 25. Junior Group Meeting, Dinner at 6:30 p.m., and meeting at 7:30 p.m., both at Child's Restaurant, 109 W. 42nd St., N.Y.C. Subject: "Opportunities for American engineers in South America and Asia Now and in Postwar Period," discussed by Prof. Thomas T. Read of Columbia University who has visited and studied the countries in question. Also short firsthand impressions on the subject by young engineers from the respective countries.

Milwaukee. April 19. Meeting will be held at Marquette University, Milwaukee, Wis. Subject: "Training for Engineering Leadership," by A. R. Stevenson, Jr., Manager, A.S.M.E., General Electric Company, Schenectady, N. Y. This will be a joint meeting with E.S.M., and Milwaukee Section of the A.S.R.E.

Ontario. April 13. Hart House, University of Toronto, Toronto, Ont., Can. Subject: "A Fuel Policy for Canada," by E. A. Allcut, University of Toronto, Toronto, Ont., Can.

Philadelphia. April 25. Engineers Club of Philadelphia, 1317 Spruce St., Philadelphia, Pa. Subject: "Latest Developments in the Field of Centrifugal Castings"—A Symposium.

April 12. Engineers Club of Philadelphia. Junior Engineers meeting. Subject: "New Techniques in Welding."

With the Student Branches

Topics discussed at the January and early part of February meetings of the British Columbia Branch were as follows: "Plastic Hydraulic Presses," by Harold Saunders; "The Engineer's Economic Status," by Leonard Wannop; "Operation of a Sheet Metal Shop," by George Blumenaur; "The Alaska Road," by Herbert Maybank, and "The Gas Turbine Engine," by John Burton. Films shown at these meetings included one on "Manufacturing of Steel," and several on mass production of planes, guns, and tanks.

This Branch held its annual banquet at the Hotel Georgia in Vancouver on February 18 when Lawrence Swanson of Heap's Engineering Company, spoke on the subject "After Graduation—What?" In his address Mr. Swanson discussed the position of the student after graduation and stressed the position of the graduate engineer in the postwar era.

Officers Elected at Clarkson Branch

Clarkson Branch held a short business meeting on January 19, at the College Chapel for the purpose of electing new officers. The new officers are: Stuart A. Fink, president; R. Carl Mix, vice-president; William C. Hibbert, secretary; Harlan S. Gates, treasurer; and James Voorhees, corresponding secretary. Dr. Eugene K. Falls will remain the faculty advisor.

On February 7, the Colorado State College Branch held a meeting at which Allan Macdonald was elected secretary, to succeed Harvey Pless. The subject of holding joint meetings with the A.I.E.E. and A.S.C.E. was discussed, as well as a contemplated trip through the light plant in Fort Collins. No definite date for the trip was set.

An announcement was made at the January 26 meeting of the Iowa State Branch, by H. A. Dipple, president of the Branch, concerning a tentative program on precision measurements to be given on February 2. At the same meeting, Professor Grace, honorary chairman, announced the approach of the annual A.S.M.E. student-paper competition and encouraged members to submit papers. A movie on lubrication sponsored by the Socony-Vacuum Oil Company, Inc., New York, N. Y., completed the evening's program. This Branch met on February 2 when D. J. Hague and R. D. Fall, representatives of the Doall Tool Company, presented slides and gave a chart talk and demonstration of precision measurements. After the meeting the members were permitted to inspect the tools for precision measurement. An "Information Please" program was given at the February 16 meeting of this Branch in which members were assigned topics to speak on during the course of the evening.

A few business matters concerning the election of new officers were discussed at the February 3 meeting of the Michigan Mining and Tech Branch after which an interesting talk on "Faith in the Engineer" and "Wartime Research and Development" was given by the chairman, Adrian Dykema.

A "social," planned at the January meeting of the Missouri Branch, was held on January 26 at which feminine talent from Stephens College helped to make the evening a great success. A total of 66 members and guests were present. This Branch met again on February 9 when L. L. Jolly of the Savage Tool Company, Savage, Minn., presented a program covering modern precision measurements on machine parts. The program consisted of motion pictures describing the theory and applications of gage blocks and of an audience-participation demonstration in their use.

At the January 20 meeting of the Montana Branch, President Ralph Challender announced that a representative of the Savage Steel Company, Savage, Minn., would speak in the near future on the subject of "Precise Physical Measurement" and present motion pictures showing the recent development in measuring devices. Members set the latter part of February as the tentative date. At the close of the meeting a membership picture was taken.

The first meeting of the semester of the New Hampshire Branch was held on February 15. The guest speaker was Dr. Eppelsheimer of the Engineering Experiment station, who gave an up-to-the-minute talk on the United States production and use of metals. New discoveries made this year were disclosed by Dr. Eppelsheimer as well as the way in which these discoveries helped solve war problems. A brief business meeting followed the talk at which the presentation of student prize papers at the Tufts College district student meeting early in May was discussed.

New Mexico Branch Reports on Four Meetings

On November 23 the New Mexico Branch met to hear Charles Gunderson give a descriptive talk on "Airfoil Characteristics." Mr. Gunderson presented illustrations on the fundamental principle of lift of the conventional airfoil and also gave a brief discourse on future airfoils. The second speaker of the evening, Dick Kendrick, gave details of "Aircraft Supercharging." This Branch met again on December 14 to hear Paul Adams speak on "Development and Uses of Plywood in Aircraft Structures." Another paper was presented by C. E. Barnhart on "Arc Welding in Industry," while David Buel presented a paper on "Automotive Fuels of the Future." At the January 11 meeting of this Branch, a series of moving pictures were shown. These pictures were furnished through the courtesy of Johns-Manville Company and disclosed some interesting facts on insulation. Max McWhirter also presented a technical paper on "Modern Gun Design." Prizes were awarded at the January 25 meeting of this Branch for the two best technical papers presented during the semester by A.S.M.E. members. Mr. Barnhart won first prize for his paper on "Arc Welding in Industry" and Max McWhirter won second prize for his paper on "Modern Gun Design." Prizes of $5.00 each were awarded the winners. Details of the convention to be held at Boulder, Colo., on or about April 20, were discussed after which motion pictures were shown.

Members and guests of the New York University Evening Branch met on January 12 at Washington Square, New York, to see a motion picture visualizing the manufacture of valves, piping, and fittings, which was provided through the courtesy of the Crane Company, Chicago, Ill., and the instrumentality of Alfred Johnson. An announcement was then made that a dinner and a tour through Jacob Ruppert's plant would be held by the Juniors of the A.S.M.E. on February 25.

Jet Propulsion for Aircraft

A meeting was held on February 7 by the Oklahoma A.&M. College Branch, Stillwater, Okla., at which Dr. Vincent Young of the mechanical-engineering department, was the guest speaker. Dr. Young discussed in detail the principles, possibilities, and limitations of the use of jet propulsion in aircraft, particularly combat types. This Branch met again on February 21 to hear Professor Chessy speak on the photoelastic method of stress analysis. He also demonstrated the procedures used with transparent plastic scale models projecting the images on a large screen for demonstration purposes.

Purdue Branch sponsored a combined meeting of the Engineering Student Branch organizations on January 20. George E. Whitlock, recipient of the first official Army citation for a civilian in this war and guest speaker, chose

A.S.M.E. STUDENT BRANCH MEMBERS AT IOWA STATE COLLEGE, LAST QUARTER as his topic, "Engineering's Challenge—War and Postwar." He had various examples of redesigned war products on display. After Mr. Whitlock's comments, an excellent new 16-mm sound movie which demonstrated the vital part engineering has played in streamlining our war production had its all-university premier that evening. Purdue University had been selected to present the first of these programs which will be held at leading engineering colleges in the United States.

This Branch met again on February 2 to hear Prof. C. W. Caldwell speak about "Electronics in Industry." Professor Caldwell explained and demonstrated some of the numerous ways that electronic tubes are used industrially.

On February 2 the Queen's Branch went on a day trip through two of Ontario's large industrial plants. The morning was devoted to an inspection of the Frost & Wood Company plant at Smiths Falls and the afternoon to a tour of Phillips Electric Manufacturing Company facilities, at Brockville. Because all Canadian plants are engaged in war work, details of the trip cannot be disclosed.

A.S.M.E. STUDENT BRANCH MEMBERS AT THE QUEENS UNIVERSITY

Film "Target for Tonight" Shown at Rutgers Branch

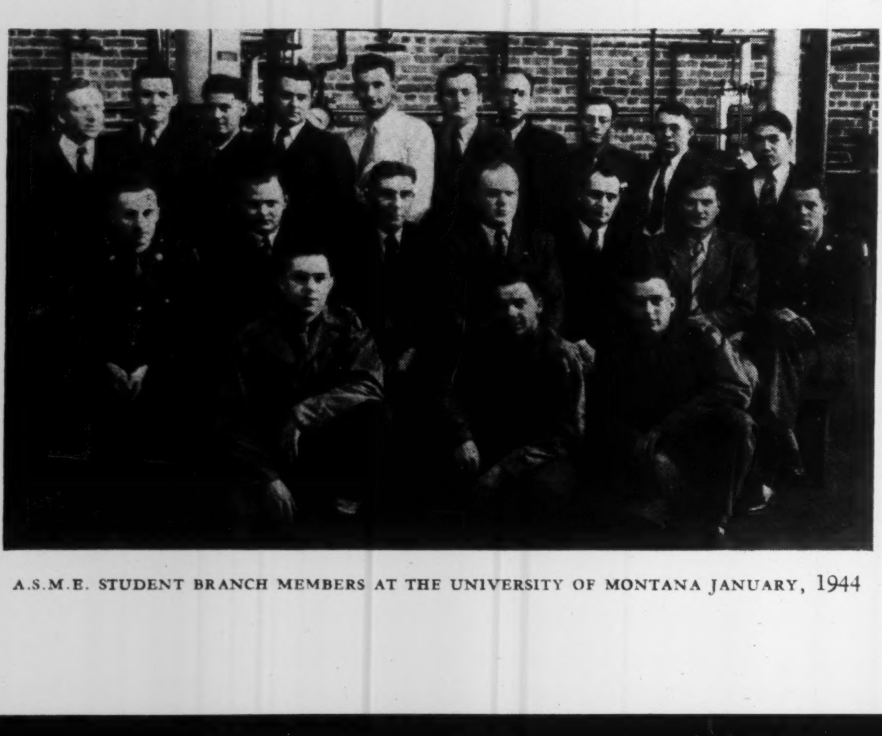
Rutgers Branch met on February 17 to enjoy a motion picture, "Target for Tonight," which depicted the mission of an R.A.F. air raid over Germany from its beginning to the return of the last plane. The picture proved extremely interesting to the 30 members and guests in attendance.

Santa Clara Branch Reports Seven Meetings

The Santa Clara Branch met on November 17 to see a colored motion picture describing "The Cargo-Thermic Process for Magnesium," which was loaned through the courtesy of Permanente Metals Corporation. Following a discussion of business matters, members of this Branch on December 1 enjoyed a film entitled "The International Harvester Diesel." The film proved of exceptional value to the members present who are engaged in the study of internal-combustion engines. Early in January the senior class in engineering of this Branch inspected the N.A.C.A. Aeronautics Laboratories, at Moffett Field, Calif. The first business meeting of the year was held by this Branch on January 12 at which a selection of speakers for the A.S.M.E. Convention was discussed. After the business session an interesting film, "Sinews of Steel," was shown, through the courtesy of the Bethlehem Steel Company. The topic of student speakers was discussed at the February 9 meeting after which two films, "Power by Wright," and "Cyclone Combustion," were shown. On February 11 a group of three professors and six students of this Branch were conducted through a limited inspection trip of the Mare Island Navy Yard. No details of the trip were given out since it was confidential in nature. The last meeting of the present school year of this Branch was held on February 23. The business of the meeting was made brief to enable Joseph E. Lepetich ample time to read the paper, "Solving Fluid-Friction Problems Graphically," which he plans to present at the A.S.M.E. Student Convention.

Designing Engineers' Problems

A joint meeting of the Tennessee Branch with the Student Chapter of the A.I.E.E. was held on February 9 at which the feature of the evening was a talk by Chesney Wilson, chemical-engineering design department of the Tennessee Valley Authority. Mr. Wilson spoke on the subject of "Problems of a Designing Engineer." After the adjournment of the joint meeting, a short business meeting was held by the A.S.M.E. members, when the Spring Meeting of the A.S.M.E. to be held at Birmingham, Ala., April 3, 4, and 5, was announced.



A.S.M.E. STUDENT BRANCH MEMBERS AT THE UNIVERSITY OF MONTANA JANUARY, 1944

Howard E. Brown was elected honorary chairman of the Texas Branch on January 3, succeeding A. D. Payne, who resigned to take a commission with the Navy. After the election, Dr. Luis H. Bartlett, assistant professor of mechanical engineering, spoke on the subject of "The Quick-Freezing of Foods," with emphasis on the work done in this field at the University of Texas. Dr. Bartlett stated there are four methods of preserving food, namely, dehydration, chemical preservation, canning, and low temperature and freezing. He explained several of the methods used for the so-called quick-freezing process, illustrating his talk with drawings. He also discussed the fundamentals of the Birdseye and other commercial processes.

On February 11 the Toronto Branch met to hear J. A. Harrington speak on "Gage Blocks and Precision Instruments." Mr. Harrington, who is chief engineer of Continental Machines, Inc., Minneapolis, and president of the Savage Tool Company, Savage, Minn., gave a brief résumé of mass production, beginning in 1913, when industry adopted measurement accuracy produced by optical means.

Annual Engineering Banquet Held at Tufts Branch

Dean Harry Burden presided as master of ceremonies at the annual engineering banquet held on February 1 in the Intramural Room of Cousen's Gymnasium, Tufts Branch. Dr. L. W. Bass, director of the New England Research Foundation and speaker of the evening, impressed upon the men the value of the engineer's education and presented considerable data of interest in regard to the high standard of compensation enjoyed by men in the engineering field, despite even severe depressions.

New officers elected at the January 18 meeting of the Tulane Branch are as follows: Edward Sanford, chairman; John Cochrane, vice-chairman; John Prendergast, secretary, and Irwin Isaacson, treasurer.

At the November 17 meeting of the Wisconsin Branch, Roy Anderson, presiding officer, announced that *Badger* pictures would be taken on December 9. It was also announced that two openings on the Polygon Board would be filled from the M.E.S.W. Following these announcements, a motion picture, "The Building of a Bomber," was shown. This Branch met again on December 9 when Bill Wendt and Wayne Marcoulliour were elected on an open ballot as members of the Polygon Board. Pictures were then taken for the *Badger* after which the group returned to the Top Flight room of the university, to see a motion picture, "Forest Rangers." On February 9 officers of this Branch were elected as follows: Elwood Buffa, president; Robert Sckribseth, vice-president, Arthur L. Nelson, secretary, and Donovan E. Rasmussen, treasurer. After the election of officers, a movie, "The Working of Magnesium," was presented.

Engineering Societies Personnel Service, Inc.

These items are from information furnished by the Engineering Societies Personnel Service, Inc., which is under the joint management of the national societies of Civil, Electrical, Mechanical, and Mining and Metallurgical Engineers. This Service is available to members and is operated on a co-operative, nonprofit basis. In applying for positions advertised by the Service, the applicant agrees, if actually placed in a position through the Service as a result of an advertisement, to pay a placement fee in accordance with the rates as listed by the Service. These rates have been established in order to maintain an efficient nonprofit personnel service and are available upon request. This also applies to registrants whose notices are placed in these columns. All replies should be addressed to the key numbers indicated and mailed to the New York office. When making application for a position include six cents in stamps for forwarding application to the employer and for returning when necessary. A weekly bulletin of engineering positions open is available to members of the co-operating societies at a subscription of $3 per quarter or $10 per annum, payable in advance.

New York	Boston Mass.	Chicago	Detroit	San Francisco
8 West 40th St.	4 Park St.	211 West Wacker Drive	100 Farnsworth Ave.	57 Post Street

MEN AVAILABLE

Plant Manager, available immediately. Former chief engineer, heavy machinery and light machine parts, engineering graduate, age 45, twenty years' executive and industrial engineering, desires permanent connection. Experienced in textile, rubber footwear, printing-ink manufacture. Me-937.

Graduate Mechanical Engineer, 47. Designer machine tools, jigs, fixtures, dies, and boring equipment. Directed experimental development, manufacturing methods, time study, and production. Been top plant executive. Desires position as chief engineer or administration work with postwar future. Me-938.

Graduate Mechanical Engineer, 27, experienced in Diesel and compressor mechanics and thermodynamics. Now head of product and tool development department in machine-tool industry requiring knowledge of hydraulics. Me-939.

POSITIONS AVAILABLE

Chief Engineer. Man who is capable of taking over engineering work in connection with plant doing light metal rolling, stamping, drawing, etc. Should be acquainted with welding and tooling. Must be fully acquainted with supervising production and design. Must know how to design costs into production work. Permanent, paying good salary. Only the highest type men will be considered. $8500–$10,000 a year. Virginia. W-3400.

General Manager and Superintendent, 45–55. Must be high-grade executive to manage small-sized manufacturing company on quantity precision metal work. Salary open. Apply by letter only. Wisconsin. W-3402.

Planning Engineer, 40–50, graduate mechanical or industrial, who knows production planning for large job shop, and also production lines. Shop employs 1000 to 2000. $5000–$6000 year. Connecticut. W-3403.

Chief Engineer to take full charge of all engineering activities, including design, development, tooling, etc. $6000–$7500 year depending upon qualifications. Connecticut. W-3406.

Mechanical Engineers to supervise methods, estimates, and engineering for small iron and steel manufacturing company. Permanent. $7500–$10,000 a year. Eastern Pennsylvania. W-3408.

Industrial Engineer. Must be graduate mechanical engineer or industrial engineer, and draft-exempt. Should be experienced in methods, job-analysis, labor and manpower schedules and evaluation. $5000 a year. Permanent. Texas. Interviews, New York, N. Y. W-3429.

Engineers. (*a*) Designer, mechanical, with considerable experience in hydraulic field. $6000 year. Rhode Island. (*b*) Sales engineer or sales representative for New York City for company manufacturing hydraulic seals. Salary open. New York, N. Y. W-3430B.

Mechanical Engineer with prior practical aviation experience. Will work with operating personnel of air lines and with manufacturers of terminal and dock facilities, and loading and unloading equipment, leading to a recommendation for kind, volume, and cost of satisfactory equipment and facilities to handle projected postwar freight business. Should be draft-exempt. Should have pleasing personality so that he can co-ordinate and develop work already under way. $7200 year. New York, N. Y. W-3437.

Industrial Engineer with 4 to 5 years' experience in men's clothing industry. Must also have experience in other industries. Work will be as field engineer, but also working in the plants of clients in time-study and methods-analysis work to develop production time standards and production-control procedures. $6000 year and traveling expenses. Massachusetts. W-3440B.

Plant Engineer to take charge of engineering and maintenance, including power plant for large manufacturing company, chemical, employing over 4000 people. Some building-construction experience desirable. $8000–$12,000 year. New York, N. Y. W-3448.

Plant Engineer, particularly experienced in plant maintenance and layout. Permanent, particularly covering postwar planning. $5000–$6000 year. Northern New York. W-3453.

Chief Design Engineer to supervise development and design of production equipment. Experience in machine tools or hydraulic equipment of value. Firm has been operating for 67 years and is figuring on permanent postwar position. About $7500 a year. Location, Connecticut. W-3472-D1776.

Production Manager. Should have at least 15 years' experience in industry involving grinding, mixing, and blending of dry materials. Experience with manufacturing synthetic resin desirable but not essential. Duties involve supervision of three medium-sized plants. Permanent. $8000–$10,000 year. Small town in New York State. W-3486.

Industrial Engineer, about 35–40, with at least 5 years' experience specializing in industrial-engineering responsibilities. Would head industrial-engineering department, controlling two or more departments, namely, labor measurement and job classification, in addition to carrying on the conventional duties of industrial engineer. Starting salary, $6084–$7440 year. Pennsylvania. W-3487.

Industrial Engineer, graduate, experienced in time and motion study, job evaluation, and installation of incentive plans, and capable of making engineering studies for improvement of methods, particularly in materials handling. About $10,000 a year. New York, N. Y. W-3510.

Development Engineer who has good background in design and who is also acquainted with functions and capabilities of machine tools. Duties will involve study of proposed postwar items to determine their manufacturing possibilities in existing plant, also to production development and design on acceptable items, Permanent. Salary open. New York, N. Y. W-3511.

Engineer who has some experience in contract negotiation and administration to assist in the handling of war contracts. This includes prime contracts and subcontracts and also contract termination. Should have some legal background. About $6000 year. For the duration. Connecticut. W-3513.

Product Promotion Engineer, mechanical, with several years' sales experience and outstanding ability in application studies, market analysis, and organizing sales activities. Will work in various fields to find need for new types and designs of industrial instruments, study their correct application, and establish their field acceptance through personal contacts with the plant executives who decide on new methods of production practices and plant operation. Excellent postwar opportunity. Pennsylvania. W-3461.

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[1] All men listed hold some form of A.S.M.E. membership.